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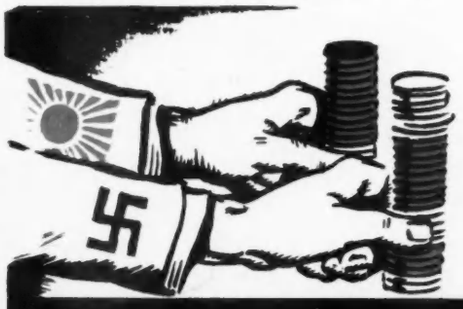

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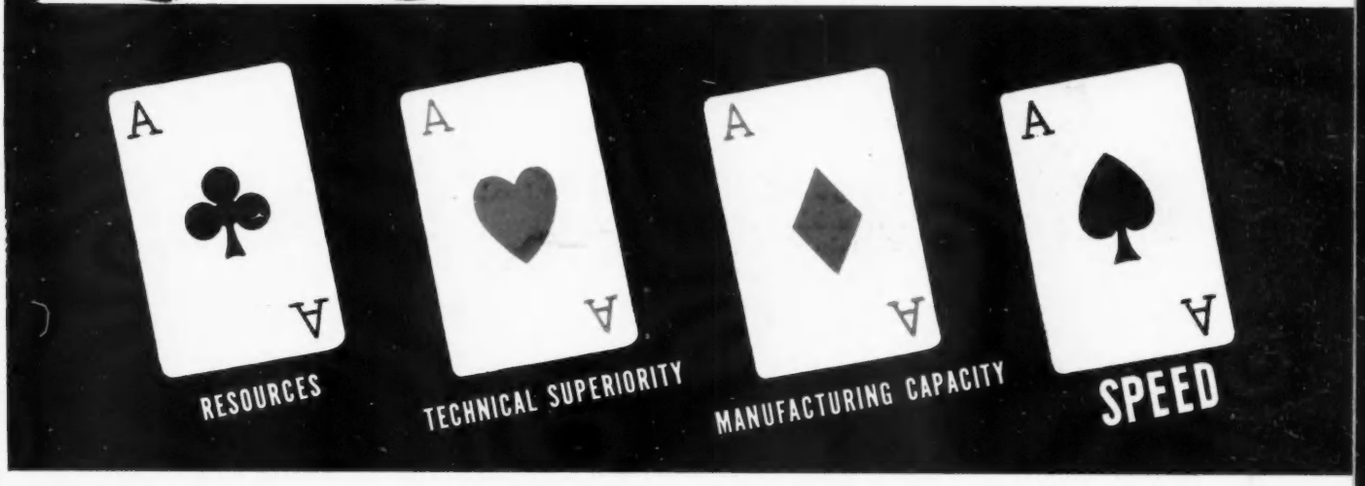

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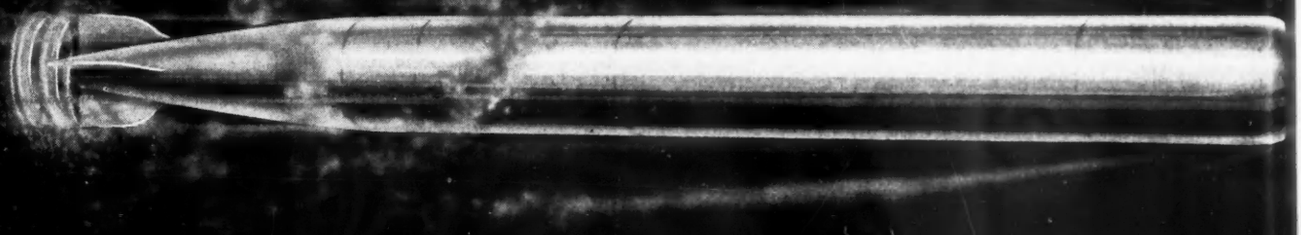

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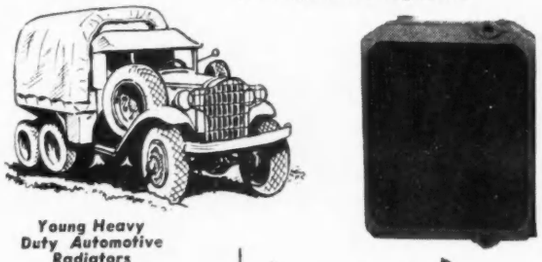

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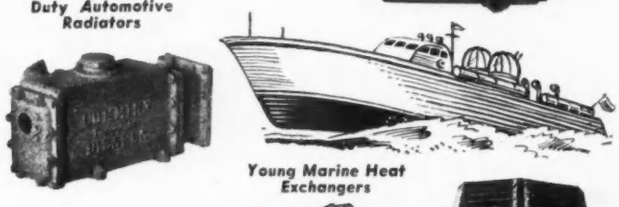

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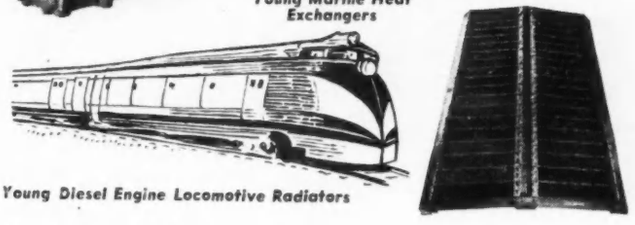

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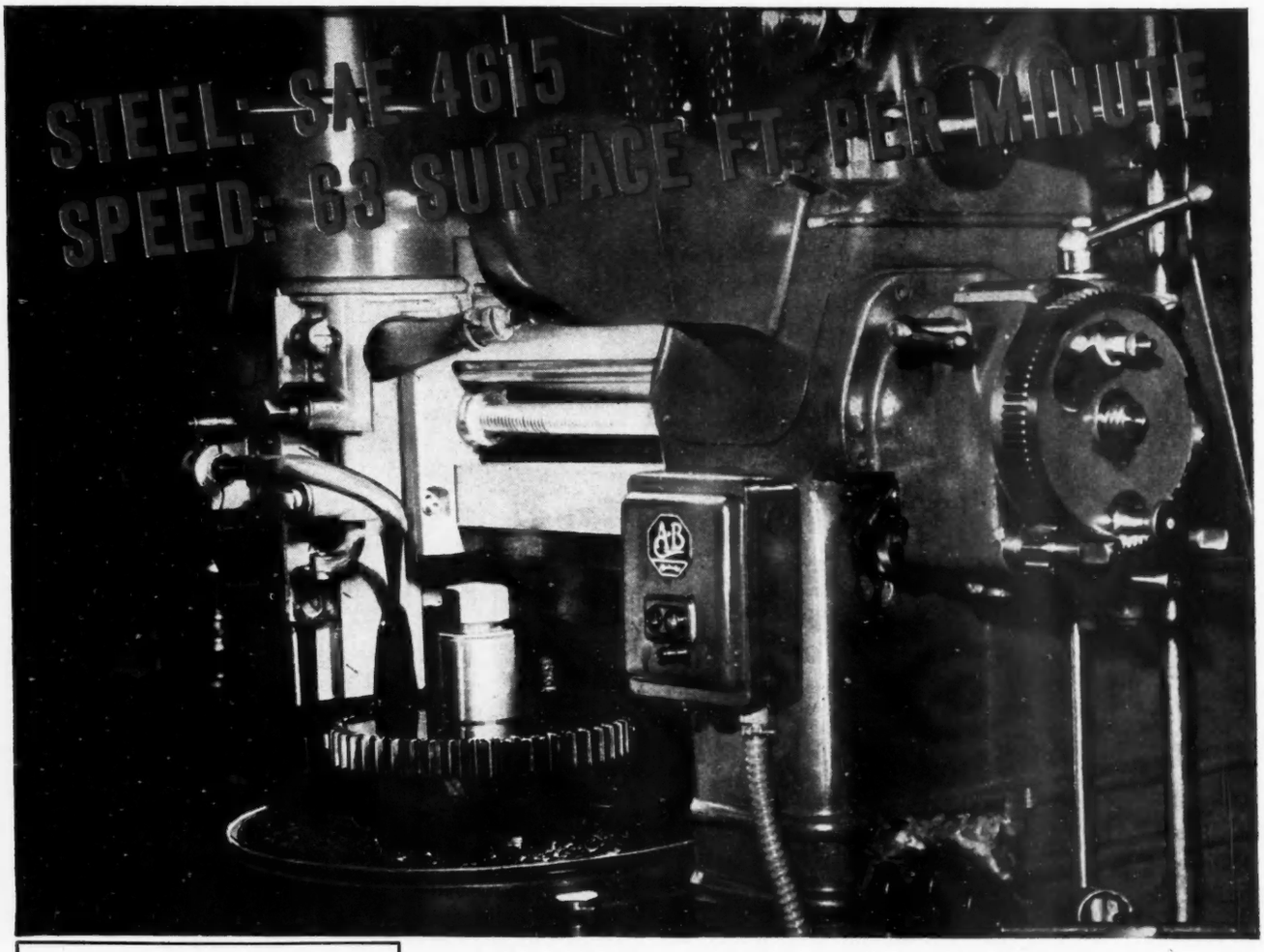

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Published on the 1st and 15th of the month

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July 1, 1942

The Specifications Problem

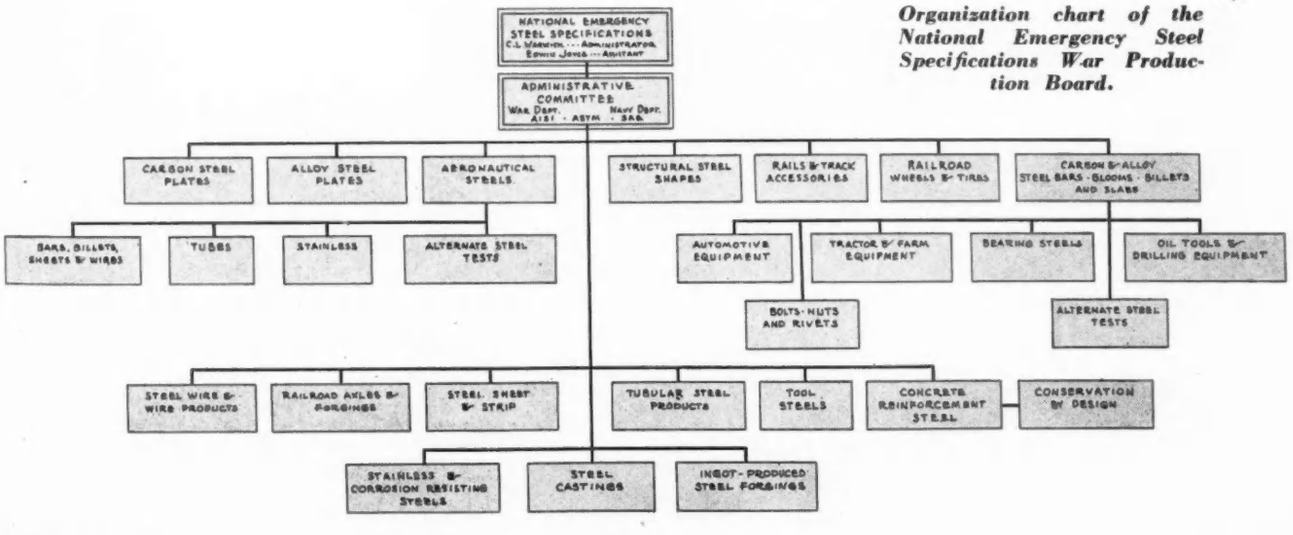
By W. C. Hirsch

WHEN, as is expected in the near future, the War Production Board makes available for the guidance of the automotive and aviation industry a comprehensive list of specifications of those "NE" (National Emergency) steels, attention will be more widely directed to the work of the Specifications Branch in the Bureau of Industrial Conservation. C. L. Warwick, secretary-treasurer of the American Society for Testing Materials, is chief of the Specifications Branch, with which the Society of Automotive Engineers, American Iron and Steel Institute, and leaders in the realm of metallurgy generally have been collaborating in the task of developing emergency alternate alloy steels, calling for lessened contents of nickel, chromium, vanadium, and other vital elements. The Iron and Steel Branch, a separate unit of the War Production Board, made a special request for carrying on this work.

Conservation of critical materials, among which metal-alloying elements that formerly were imported chiefly from the Far and Near East are perhaps the most important, has come to be the outstanding objective of all of the Government's war agencies having anything to do with materials, and not least so of the Specifications Branch. Its activities make possible orderly procedure under conditions that otherwise either would have seriously impaired uninterrupted production or let down the bars reared by recognized standards against unfit material. Emergency Alternate Specifications have been worked out. These take into account the relative availability of the material, the possible need of it in more or just as vital uses, the effect of modifications on properties and the functional efficiency of mechanism. In this work, the Specifications Branch collaborates with the Federal Specifications Executive Committee, on which serve a large number of leading authorities in their respective fields.

From the very outset, when war conditions made the obtaining and transportation of certain ores and metals a steadily increasing problem, it has been the policy of the Specifications Branch to provide the necessary relief without tampering in any way with existing Federal specifications. The latter have not and are not being changed. Instead, alternate specifications have been set up, the use of which is in the discretion of the different contracting agencies of the Government. To make this perfectly plain, each of these specifications starts out with the following

(*Turn to page* 88, *please*)



Organization chart of the National Emergency Steel Specifications War Production Board.

Aircraft Machine Guns Replace Automotive Accessories at

Brown-Lipe-C

Complete reorganization of manufacturing facilities necessary to make this small, but intricate mechanism requiring 2800 different operations

FROM automotive accessories to machine guns—that's the story of the conversion to war production made by Brown-Lipe-Chapin Div., General Motors Corp., last year. Many independent parts makers will find a parallel in their own situation in changing over from peacetime activity to the manufacture of the weapons of war.

In the normal course of business, this company was established to produce a variety of automotive accessories, including—headlamps, die castings, bumper bars, hub caps, grille frames, grilles, fog lamps, license plate brackets, and steering gears. It will be observed that the manufacturing facilities for these parts consisted principally of light punch presses, polishing lathes, plating tanks, paint ovens. Similarly, the skills of the workers were confined, in the main, to the operation of such equipment.

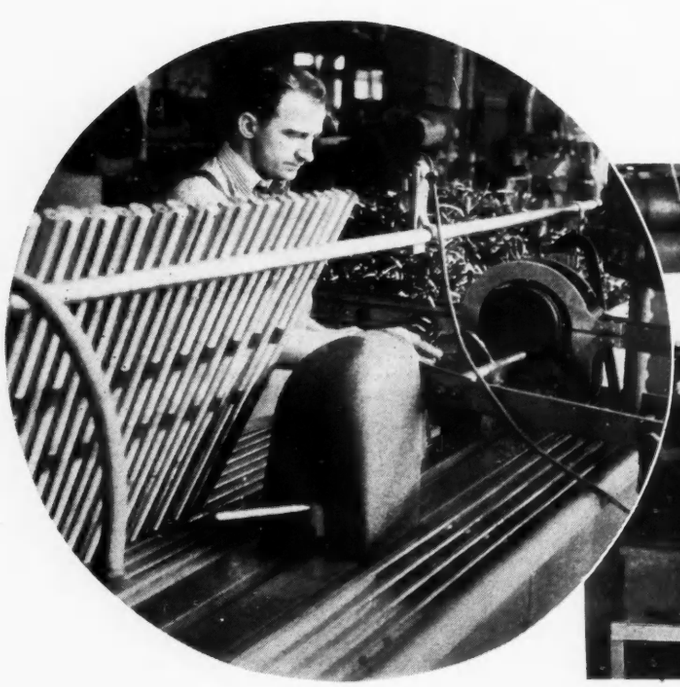
Our readers can appreciate the problems faced by the management when they were advised late in 1940 that the division had been awarded a contract to produce aircraft machine guns. Not only was it necessary to make an intimate study of the manufacturing operations involved and to take steps to order special machinery, fixtures, and gages; but it was necessary simultaneously to clear away some space to accommodate the initial set-up for this new activity.

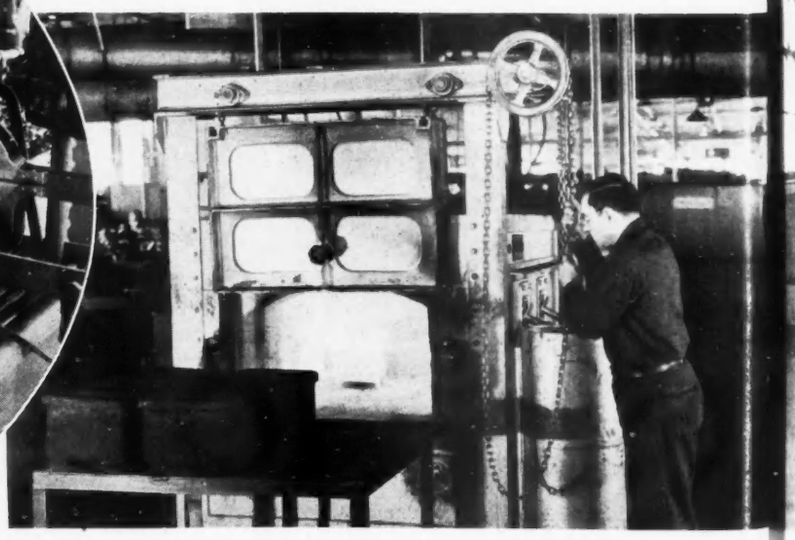
By the turn of 1942 all of the peacetime activity had been discontinued and all evidence of auto accessories manufacture had vanished. Today all of the energies of the organization are devoted to the maximum output of machine guns and spare parts, including spare gun barrels.

Profiting by the experience of other General Motors divisions, this unit explored the warehouse stores of some of the Government arsenals and uncovered about 225 specialized machine tools which were used 22 years ago in the manufacture of the machine guns of the last war. These included the familiar Pratt & Whitney profiling machines, milling machines, rifle

(Circle left) Gun barrels are subjected to the familiar Magnaflux test to assure freedom from surface imperfections.

(Below) A view in the heat treating department showing one of the normalizing furnaces.





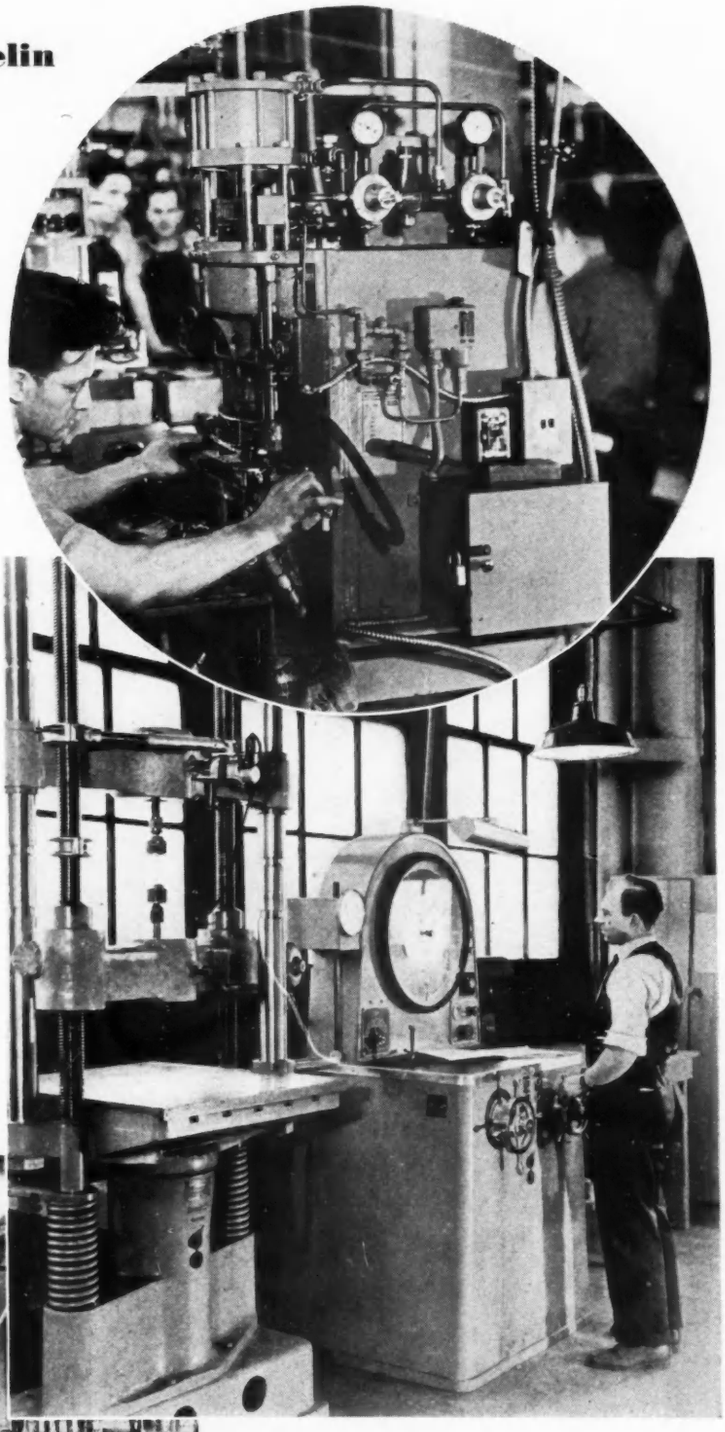
By Joseph Geschelin

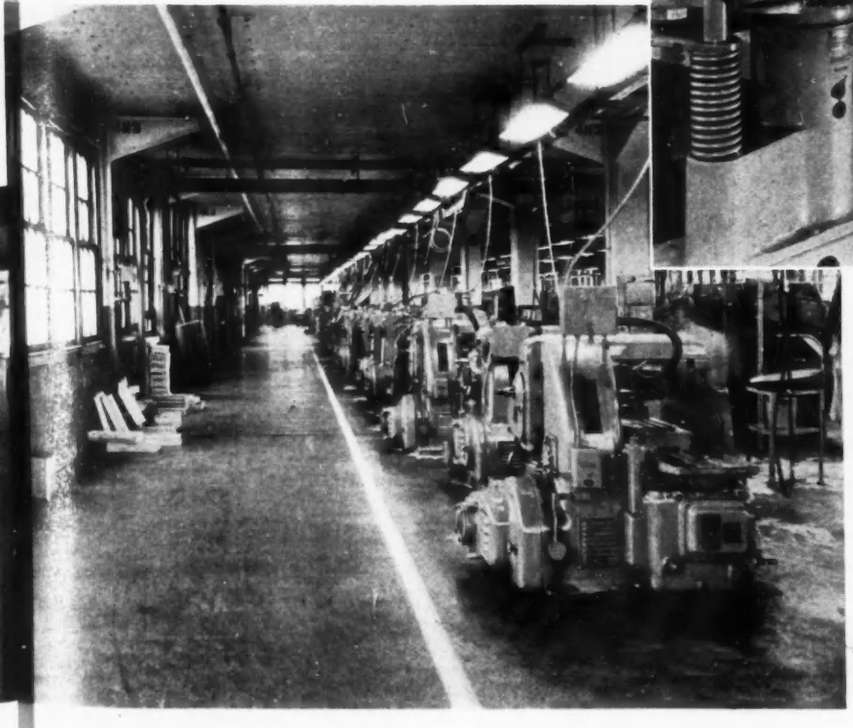
Chapin Plant

This is the Seventy-second in the series of monthly production features

drillers, rifle reamers, etc. All was old style, belt-driven equipment. A special department was set up for rehabilitating these machines —degreasing the parts, scraping and re-bushing bearings and ways, and in general placing each machine in good operating order. In addition, each machine was individually motorized in keeping with modern practice.

As the machine gun operation was extended to every corner of the plant, the modern ceiling mounted bus duct was in-





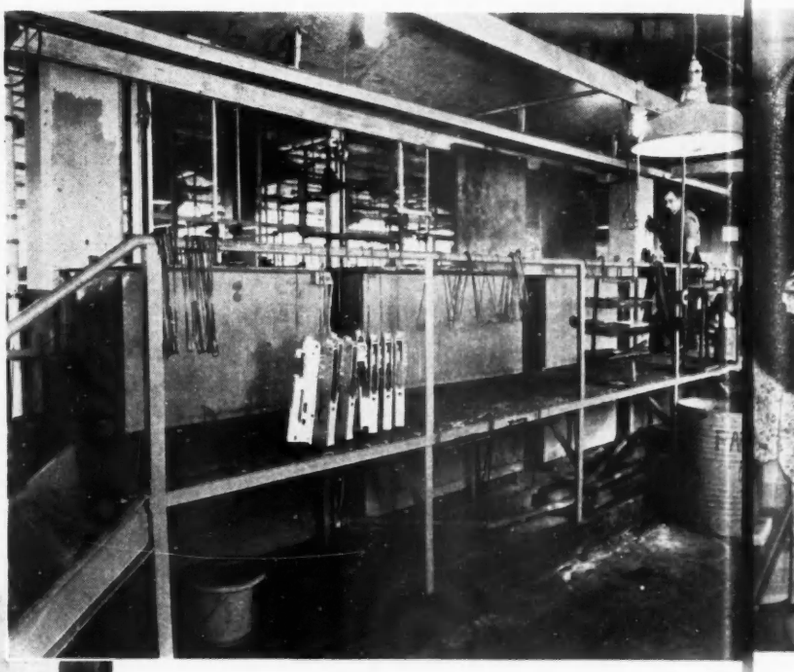
(Circle top) One of a battery of National Electric Machines, resistance welders employed in the fastening of breech casing assemblies. This was formerly a hot riveting operation.

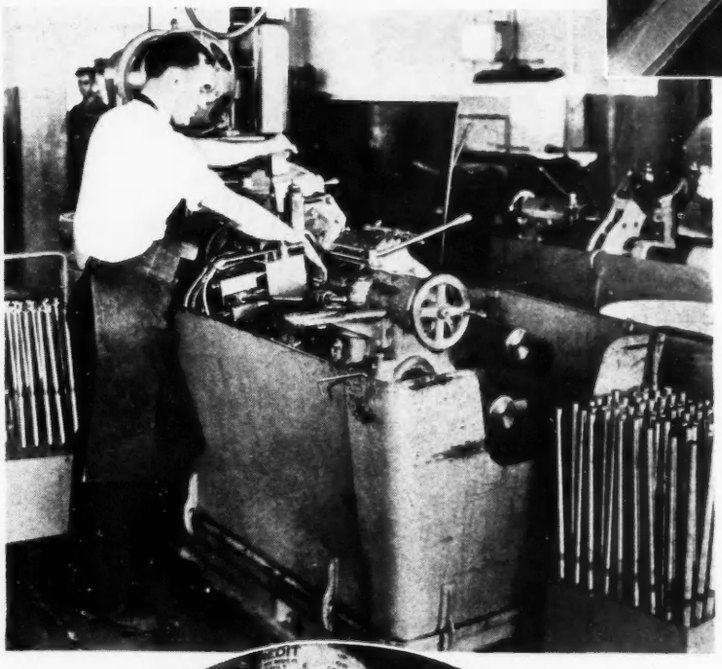
(Above) New Baldwin-Southwark tensile testing machine is found in the metallurgical laboratory.

(Left) Looking down a long bay fitted with Cincinnati milling machines and Kearney & Trecker mills of various types and sizes in the trunnion block department. Note the excellent lighting and the overhead power duct for convenient plugging-in of the machines.

stalled to facilitate machine installations and to simplify the wiring problem. This arrangement makes it possible to shift equipment readily from one place to another, expediting such changes as have to be made even after the plant is in full operation.

Coming to the product, we find that this machine gun has nearly 200 different components, of which many of the smaller items are purchased from outside sub-contractors. The modern machine gun is an extremely intricate mechanism, made up largely of forgings and tough alloyed steels from which a vast amount of metal must be removed. Roughly it may be estimated that at least 2 3 or even 3/4 of the original weight of some parts must be removed in the form of chips on milling machines, profilers, drills, etc. This order of metal removal, unique to the weapons of war, requires unusually heavy and rigid machine tools, massive work-holding fixtures, and special cutting tools of every variety.





(Above) Gun barrels, breech casings and other exposed parts of the machine gun are Parkerized for protection against corrosion in this Parkerizing unit.

(Left) Fay automatic lathe is one of the major items of equipment in the gun barrel machining line.

(Circle below) Rapid finishing of surfaces of small parts of the machine gun is done on this high speed Delta sander.

Moreover, due to the magnitude of metal removal there is an endless variety of individual set-ups for each piece of the gun, thus making each department of unusually large size and containing a correspondingly large number of machine tools. It is estimated that the finished unit requires over 2800 different operations. Just one small part—the bolt—requires 138 operations of metal removal, plus 42 inspection operations, or a total of 180 operations.

Among the principal items of machine tools found in this plant are the following—Pratt & Whitney profiling machines, largely the old rehabilitated machines salvaged from Government arsenals, plus some modern models recently made available; Pratt & Whitney rifle drilling, reaming, chambering, and rifling machines; Cincinnati heavy duty milling machines; Kearney & Trecker heavy duty milling machines; Sundstrand milling machines, including several of the new

(Circle) Front view of a line of Cincinnati mills in the trunnion and bolt department, emphasizing the heavy form-milling cutters employed here.

(Top left) This new Sheffield air gage speeds up the inspection of gun barrel bores, makes it possible to measure every part of the bore quickly and accurately.

heavy-duty climb-milling machines; Blanchard surface grinding machines; Warner & Swasey turret lathes; Bardons & Oliver turret lathes; Brown & Sharpe automatic screw machines; Leland-Gifford drills; Allen sensitive drills; W. F. & John Barnes rifle drilling machines; a huge LaPointe broaching machine for rifling; Fay automatic lathes; Lo-Swing lathes; Norton, Cincinnati, and Landis grinders; Abrasive grinders; National Electric Welding machines for hot riveting.

In keeping with modern practice, the individual components of the assembly have been segregated and departmentalized to approximate straight-line production. One of the largest departments, for example, is replete with equipment for the machining of small miscellaneous parts. Another department is devoted to the machining of the larger plate forging which requires P & W profiling operations, milling on Cincinnati and Kearney & Trecker heavy duty mills; also includes operations on the new Sundstrand millers.

There is a large turret lathe department equipped with Warner & Swasey machines, Bardons & Oliver machines and Brown & Sharpe automatics. Side plates are handled in a separate department containing P & W profiling machines, Leland-Gifford sensitive drills, Blanchard surface grinders, and a massive new Sundstrand climb milling machine fitted with a B & S magnetic chuck for holding the work. Next in order are departments for producing the barrel extension and for machining the trunnion block.

There is a self-contained heat treating department, featuring some of the latest models of the familiar Lindberg normalizing furnaces, and provided with automatically recording furnace control instruments. These facilities are supplemented with a small section equipped with Baird tumbling barrels for cleaning and burring many small parts. In addition, there are benches for taking care of the multitude of filing and burring operations. Adjacent to the heat treating department is a well-equipped metallurgical laboratory. One of its outstanding features is a new Baldwin-Southwark tensile testing machine.

Most of the individual grinding operations are routed to the production grinding department which contains Norton, Cincinnati, and Landis grinders, and a battery of Abrasive grinders. Too, there is a centralized polishing and buffing department to take care of the final finishing operations.

Most of the major parts such as the barrel, side plates, bottom plate, etc., are given a Parkerizing treatment for surface protection against corrosion. This is done in a special department provided with a large conveyorized Parkerizing unit. Before immersion in the tank, the parts are cleaned in Pangborn sandblasting machines.

Several departments are devoted entirely to subassembly and final assembly operations. Major subassembly is the case assembly line. Here the component parts are fitted together into an acceptable unit by assembly in special jigs. Then the fastening holes are drilled on Allen sensitive drill presses. Following this, the parts are dis-assembled, wired together, stamped with a suitable identification, and sent on to heat treat. After heat treat, the parts return to the case assembly line where they are matched into sets and re-assembled in the master jigs. For permanent fastening, the parts are hot riveted in a battery of National Electric Machine resistance welders.

(*Turn to page* 78, *please*)

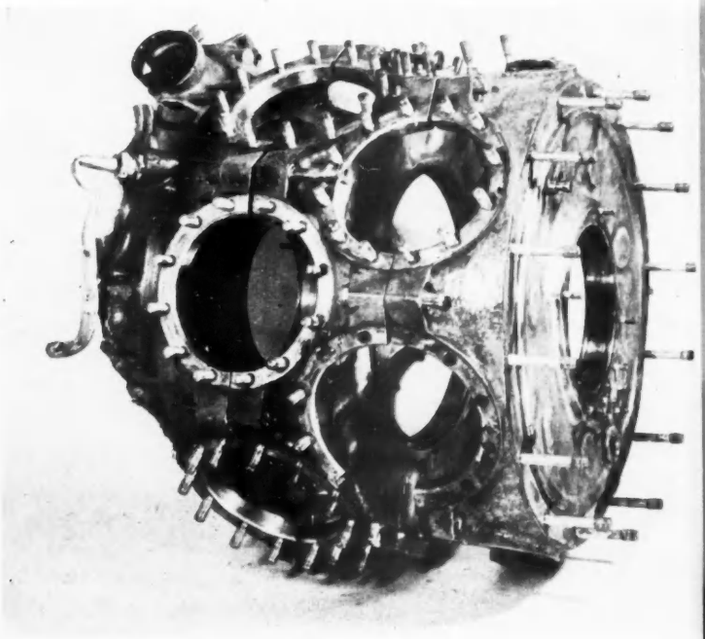
Mitsubishi

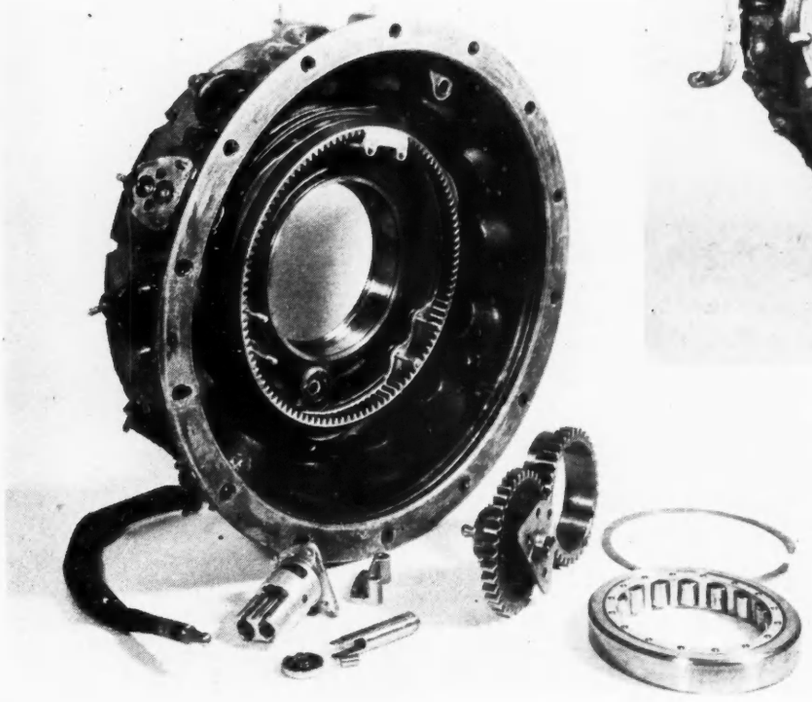
WHAT was probably the first detailed description of a Japanese aircraft engine ever published in this country was contained in a paper by W. G. Ovens of the Wright Aeronautical Corp., presented at a joint meeting of the S.A.E. and the Engineering Society of Detroit on June 8. The engine dealt with was the Mitsubishi Kinsei, a 14-cylinder, radial, air-cooled model of 5.50-in. bore and 5.92-in. stroke, of which a sample, somewhat worse for the effects of a crash, was exhibited at the meeting. In passing an over all judgment on the design, the author said those responsible for it had ingeniously combined what they apparently believed to be the most desirable features of a number of foreign makes—proven features all of them—and that manufacturing methods and equipment of the originators of these features probably were used to produce parts comparable in quality to the originals. He characterized the engine as a highly dependable though not highly developed piece of equipment, which probably was produced under time and tooling limitations which we would consider nearly impossible.

Though the plane from which the engine was taken had crashed, most of its parts were in excellent condition. There was some indication that a thrust bearing on the impeller of the supercharger had failed before the crash, but that the shaft had continued to operate against a spherical surface.

The only weak point in the design noted by the author was the limited cooling surface. The total cooling area per cylinder was somewhat less than 1000 sq. in., which probably would limit the continuous output to about 0.5 hp. per cu. in., and the pressure drop due to the baffle plates provided to keep the engine from detonating "would make an American aircraft designer very unhappy."

Materials used in the various parts were analyzed, and indicate that—at least at the time the engine was built—there can have been no shortage of such strategic materials as nickel, cadmium, chromium, cobalt, copper, molybdenum and tungsten. The one magnesium alloy found was similar to AMS 4424, except





(Above) The three-section main crankcase. (Left) Intermediate magnesium alloy casting of front crankcase. It mounts the valve tappet assembly and fourth main bearing.

Kinsei Engine

that the aluminum content was somewhat lower. Of aluminum alloys, 17S is used in many parts, such as the main crankcase, tappet guides, piston-pin plugs, etc. For pistons, cylinder heads and the supercharger front housing another alloy is used, containing 3.93 per cent copper, 1.37 per cent magnesium, and 1.67 per cent nickel. This alloy is used in both the cast and forged states.

An all-purpose steel, which is either case-hardened or through-hardened, is used for connecting rods, crankshaft, valve rockers, etc. It contains approximately 1.5 chromium, 3.5 to 4.5 nickel, 0.3 to 0.4 molybdenum, 0.35 to 0.50 manganese and varying small quantities of silicon and copper, apparently as impurities. Carbon content is varied as required.

The same steel with molybdenum reduced and 0.5 to 0.9 tungsten and 0.2 to 0.4 cobalt added is used in the propeller shaft and in the starter and accessory driveshaft, the latter being case hardened. This composition may possibly be a compromise for making the best use of available scrap materials. Propeller reduction gears, cam and knuckle pins are carburizing 4.5 nickel steel plus 0.8 chromium approximately. Nitriding is used only in the cylinder barrel, the steel of which conforms closely to AMS 6470. Nitride depth is 0.010 in. to 0.020 in. in two barrels cut. Core hardness varied from Rockwell C-22 to C-34 in one specimen.

Plating is used extensively. Cadmium plating appears on the supercharger oilseal rings and most of the propeller shaft, in addition to valve springs, valva rockers, pushrods and impeller shaft. Chromium plate is used on the under side of inlet-valve heads and on the outside diameter of the upper compression ring on the pistons.

Bushings for the most part are located by threaded pins. The bushing and the part containing it are tapped after assembly, the pin is screwed in and then machined flush inside and out. "The resulting sharp

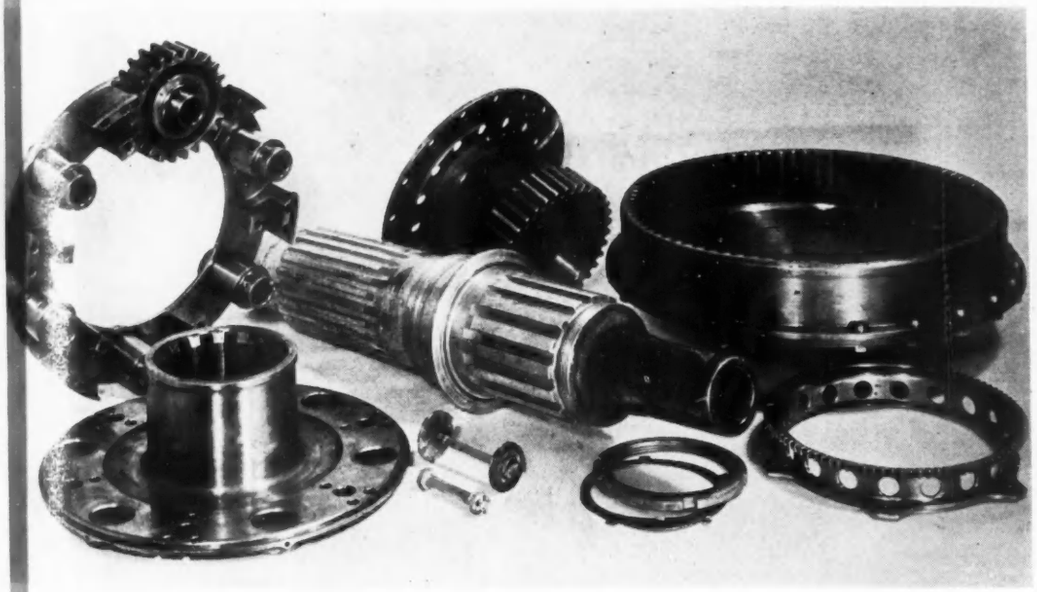
General Data

Type	Radial air cooled
Cylinders	Fourteen, 5.5-in. bore x 5.92-in. stroke
Cylinder arrangement	Two radial banks of seven
Engine diameter	47 in. approx.
Piston area	332 sq. in.
Displacement	1970 cu. in.
Compression ratio	6.6:1
Supercharger	Centrifugal 9.62-in. diam. impeller
Supercharger drive	8.48 x crankshaft

Performance Data

Based on 95 to 100 octane fuel and American Standards of service life

Maximum cruise	600-650 hp—2000 rpm
Rated	850 hp—2250 rpm to 8000 ft
Military rated and take-off	1050 hp—2500 rpm to 5500 ft



Propeller reduction gear parts.

corners," says the author, "would worry us greatly."

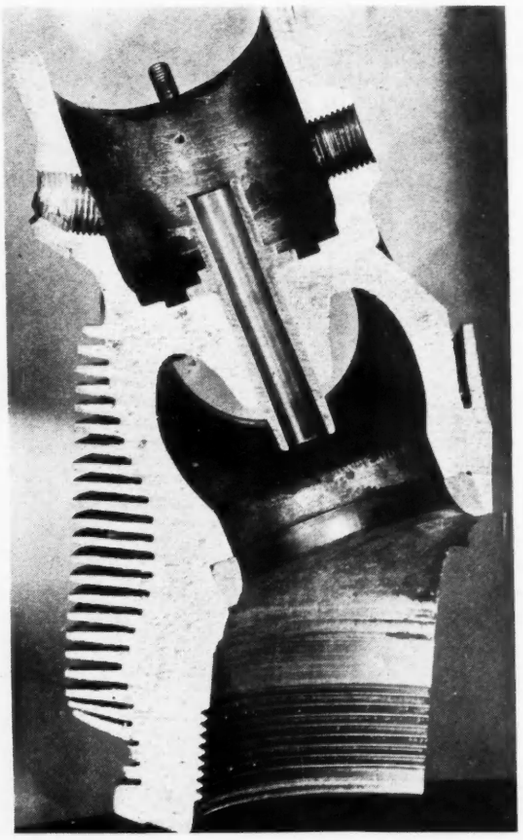
The crankcase is made in three sections, with joints in the cylinder row center planes, which are held together by 0.475-in. through bolts, one between each pair of adjacent cylinders. Cylinder decks are approximately 0.88 in. thick at the bore and carry 12 equally spaced studs for cylinder mounting. These studs are approximately 3/8-20 at the nut end, 7/16-17 in the crankcase, and necked to 0.36 in. in between. The deck height is approximately 9.8 in. from the crankshaft axis. The three main crankshaft bearings fit bearing retainer rings shrunk and pinned in the crankcase diaphragm hubs, the bores for which are 6.65 in. front, 11.13 in. center, and 6.3 in. rear. Only the front bearing-retaining ring is flanged, and crankshaft float is limited by it.

The crankshaft is in three pieces. Crankpins are 3 in. in diameter by 3 3/8 in. between cheek faces. Assembly of the one-piece master rod is made possible by splitting the shaft near the center of the crankpin. Crankpin and abutting surfaces are carburized to Rockwell C-60 to a depth of 0.044 in. The core hardness is Rockwell C-44. A splined joint is used, with 36 involute splines of 2.30-in. O.D. The male splines on the forward half form a tight fit with the female splines on the rear half. The entire joint is held together by a necked capscrew. Steel counterweights are secured by rivets.

Main bearings of NSK manufacture are as follows: Rear, sixteen 18 by 18-mm. rollers, 3.54-in. I.D. by 6.30-in. O.D. by 1.14-in. width; center, 23 balls, 8.50-in. I.D. by 11.10 in. O.D. by 0.94 in. width; front, nineteen 17 by 17-mm. rollers, 3.90 in. I.D. by 6.70 in. O.D. by 1.06 in. width of outer race and 1.18 in. width of inner race. Inner races of both front and rear bearings are of the conventional two-piece construction. The fourth main bearing is of the same size as the rear bearing, except that the inner race is integral with the hub of the driving member of the reduction gear.

The front extension of the crankshaft front section incorporates, in addition to the front journal, square splines for mounting the driving gear. There are 14 splines, spaced on the basis of 15, with one omitted. The inside of the extension is bored out to receive a copper-lead-lined, heavy steel-backed bushing for supporting the rear propeller-shaft journal. The rear extension of the crankshaft rear section is splined internally to receive a coupling for the starter- and accessory-drive shaft.

The oil passage through the crankshaft center cheek is of some interest, in that a large axial hole serves as a point to start diagonal drilled oil holes to each crankpin. These oil holes are offset to allow the drilling spindle to miss the crankpin. The large hole is then plugged by means of a pressed-in spool of 17S aluminum alloy. Lubrication to the master connecting-rod bearings is by means of five holes in each crankpin. Four of these holes (two on each side) are located in a plane normal to the plane of the crank throws. The fifth hole is close to the center of the pin, a few degrees in advance of the plane of the crank throws on the side which is unloaded by rod inertia. Oil jets for piston lubrication are provided by



Section of the cylinder head (left) intake port; (right) exhaust port.

Crankshaft parts.

holes drilled through the counterweights to the main-journal bores.

The connecting rod system for each bank is of the conventional master and articulated-rod type. The master rod (11.25 in. between centers) is of I section, forged of the all-purpose steel, and hardened to Rockwell C-40. The master-rod bearing is a heavy steel-backed, copper-lead-lined, shrunk-in bearing with a flange at one end. The steel back, which is 0.094 in. thick, is soft. The lining, which is 0.028 in. thick, contains a small amount of tin and 1 per cent of silver.

Articulated rods are 8.70 in. between centers. They are of I section and have tin-bronze bushings at both ends. The material is uniform and very free from inclusions. Its hardness is Rockwell B-70. The knuckle-pin bushing is 1.03 in. in diameter by 1.57 in. long. Piston-pin bushings in both master and articulated rods are 1.25 in. by 1.81 in. long. Knuckle pins are flanged at one end and locked in the master rod by lock plates screwed to the rod flange in the conventional manner. Pins are drilled from both ends, leaving a web at the center. The end opposite the flange is plugged for bushing lubrication. Rod weights are etched on each end of each rod and are approximately 0.93 lb. for the knuckle-pin end and 1.05 lb. for the piston-pin end of the articulated rod; 9.13 lb. for the hub end and 1.72 lb. for the piston-pin end of the master rod. The equivalent rotating master weight used is 37.6 lb.

Cylinders have a nitrided steel barrel and an aluminum-alloy head. Barrel-cooling fins, 0.45 in. deep, are machined on. There are 21 fins on a length of 2.75 in., giving a spacing of 0.131 in., which is quite close. Mounting flanges are also turned on the barrel, and spot-faced for flat washers at the cylinder-mounting nuts. Barrels project approximately 2 in. into the interior of the crankcase.

Cylinder-head fins are closely spaced (five per in.) and average 0.90 in. in depth. This gives a relatively small cooling area. A small angle between valves (56 deg.) hinders the application of fins at the top of the combustion chamber dome. Heads are secured to barrels by means of a screw joint of 3 mm. pitch (8.5 threads per in.). A shrink-fit pilot is provided both above and below the threaded section of the joint. The joint is completed by screwing the tapered lower face of the head against the upper side of an angularly machined fin. Presumably the parts are so machined that the tip of this angular fin contacts first. Cylinder-barrel threads run out into a relief. Head threads are milled and no relief is provided. The cylinder head shows a Brinell hardness of 60.

Two spark-plug inserts are screwed into the head. The left-hand threaded joint is tapered. No other locking means is provided. The inserts, of aluminum bronze, are located at the front and rear, slightly off center, and are approximately radial to the interior contour of the dome. Valve-seat inserts are shrunk into bores in the cylinder head. The steel exhaust insert is alloyed with nickel, chromium and considerable manganese, and it shows a Rockwell hardness of B-87. Intake inserts are of aluminum bronze. Tin-

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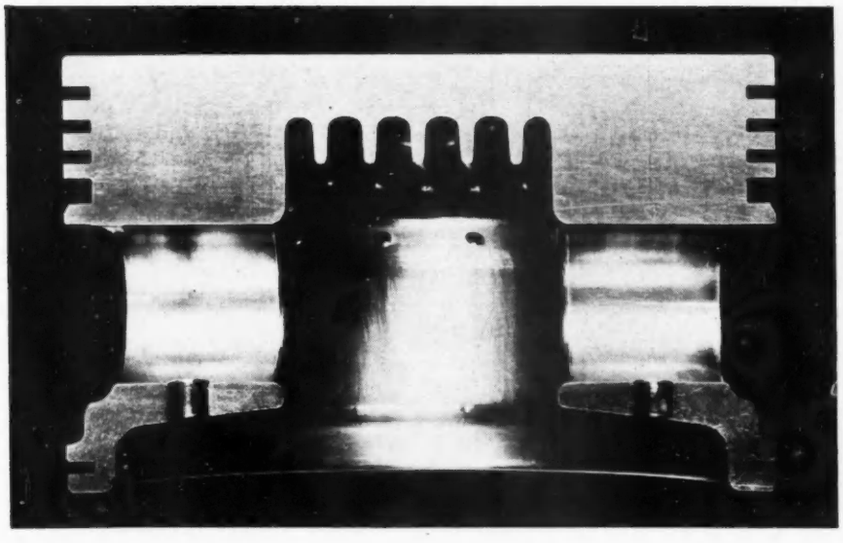


Section of piston at pin axis.

Excess Air

It is known that there is a definite relationship between the excess air and the brake mean effective pressure of an internal combustion engine, but that relation is seldom expressed in a convenient form. Dr. P. H. Schweitzer at the recent A.S.M.E. Oil and Gas Power Meeting at Peoria, Ill., submitted the following handy formula:

$$\text{bmep} = 180 \frac{0.4}{f} \frac{14.4}{r_{\text{th}}} \frac{\eta_{sc}}{1 + (\lambda - 1)\eta_{sc}} \eta_{\text{vol}} \qquad (1)$$

where f denotes the fuel consumption, lb. per bhp.-hr., r_{th} the chemically correct air-fuel ratio, η_{vol} the volumetric efficiency, η_{sc} the scavenging efficiency and λ the excess air factor which is defined as the actual air-fuel ratio divided by the chemically correct air-fuel ratio.

Formula (1) has a universal validity for either four or two-stroke cycle engines, for carburetor engines, and fuel injection engines of both compression ignition or spark ignition type, normally aspirated or supercharged engines of all types.

For four-stroke cycle engines ($\eta_{sc} = 1$), Formula (1) is reduced to the still simpler formula

$$\text{bmep} = 180 \frac{0.4}{f} \frac{14.5}{\lambda r_{\text{th}}} \eta_{\text{vol}}. \qquad (2)$$

The derivation of Formula (1) is given later in this article. Here it is of interest to point out the implications of these formulas and the service they can render to the internal combustion engineer.

A typical Diesel fuel which is composed of 7 parts of carbon and 1 part of hydrogen requires 14.5 lb. of air to burn 1 lb. of it completely. With a fuel consumption of 0.4 lb. per bhp.-hr. and a volumetric efficiency of 100 per cent (which is the upper limit for normally aspirated engines), according to Formula (2) the maximum b.m.e.p. is

$$\text{bmep}_{\max} = 180 \text{ psi.}$$

This is only obtained, however, with an excess air factor of $\lambda = 1$. If we have 50 per cent excess air (which is an average figure for Diesel engines) and the volumetric efficiency is $\eta_{vol} = 0.7$,

$$\text{bmep}_{\text{diesel}} = 180 \frac{0.4}{0.4} \frac{1}{1.5} 0.7 = 84 \text{ psi.}$$

A carburetor engine with a specific fuel consumption of 0.5 lb. per bhp.-hr. operating with an air-fuel ratio of 14.5 (close to the chemically correct mixture) and a similar volumetric efficiency gives a b.m.e.p.

$$\text{bmep}_{\text{carb}} = 180 \frac{0.4}{0.5} \frac{1}{1} 0.7 = 100 \text{ psi,}$$

showing an advantage of 16 per cent over the Diesel. In either type of engine the b.m.e.p. is directly proportional to volumetric efficiency and inversely proportional to the specific fuel consumption and excess air factor.

This is not exactly true in a two-stroke cycle engines or in a four-stroke cycle engine with appreciable valve overlap. Then the scavenging efficiency enters in a manner shown by Formula (1) which is represented by chart Fig. 1.

Scavenging efficiency is defined as the amount of fresh air in the cylinder charge divided by the total cylinder charge; volumetric efficiency as the total cylinder charge divided by the piston displacement. It is apparent that 180 psi b.m.e.p. can hardly be exceeded in normally aspirated engines, but with supercharging η_{vol} can be made larger than 1 and the b.m.e.p. goes up directly with η_{vol}.

If in Formulas (1) and (2) the fuel consumption is expressed in pounds per indicated horsepower, the formulas give mean indicated pressures rather than brake mean effective pressures.

Derivation of Formula (1):

The horsepower output of an engine is

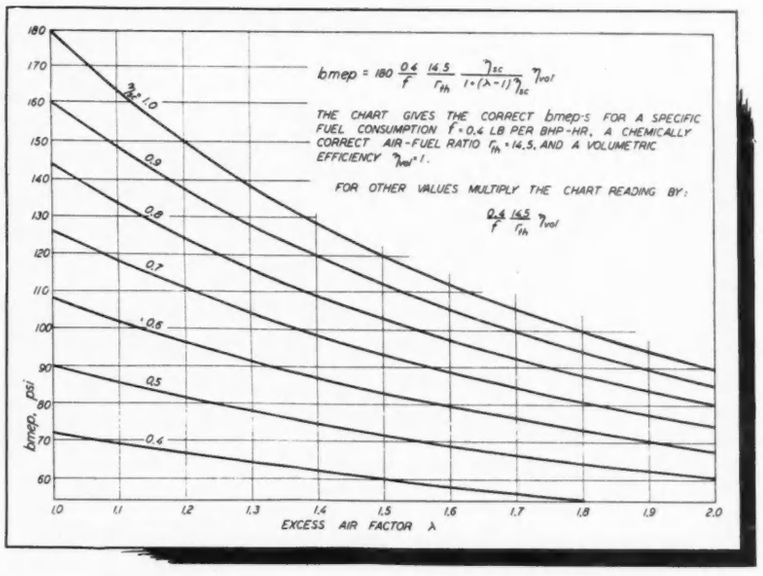

bmep = 180 0.4/f 14.5/r_th η_sc/(1+(λ-1)η_sc) η_vol
THE CHART GIVES THE CORRECT bmep'S FOR A SPECIFIC FUEL CONSUMPTION f = 0.4 LB PER BHP-HR, A CHEMICALLY CORRECT AIR-FUEL RATIO r_th = 14.5, AND A VOLUMETRIC EFFICIENCY η_vol = 1.
FOR OTHER VALUES MULTIPLY THE CHART READING BY: 0.4/f 14.5/r_th η_vol
η_vol = 1.0
0.9
0.8
0.7
0.6
0.5
0.4
bmep, psi
EXCESS AIR FACTOR λ

Fig. 1. Relation between excess air factor and Bmep. This chart covers both four-stroke and two-stroke cycle engines of all types at any load

and BMEP

The definite relationship between these two factors is the basis of a handy formula for determining the bmep of either four or two-stroke cycle, internal combustion engines.

$$\text{hp} = \frac{\frac{V_{disp}}{12} \times \text{bmep} \times \frac{2n}{c}}{33{,}000}, \qquad (3)$$

where V_{disp} is the displacement volume in cu. in., n the r.p.m. and c the number of strokes per cycle.

Naturally the horsepower is also equal to the total fuel consumption divided by the specific fuel consumption

$$\text{hp} = \frac{F_h}{} = \frac{V_{\text{pure}} \times \rho \times \frac{2n}{c} \times 60}{r \times f \times 1728} \qquad (4)$$

$$= \frac{V_{\text{pure}} \times \rho \times \frac{2n}{c} \times 60}{r_{th} \times \lambda \times f \times 1728}$$

where V_{pure} is the volume of pure air under normal temperature pressure conditions in the cylinder before combustion (see Fig. 2), r the actual, r_{th} the theoretical ratio, $\lambda = r/r_{th}$ the excess air factor, and δ the weight of 1 cu. ft. of air under NTP conditions.

From (3) and (4)

$$\text{bmep} = 13{,}750 \frac{\delta}{\lambda \times f \times r_{th}} \frac{V_{\text{pure}}}{V_{disp}}.$$

One cu. ft. of dry air under NTP conditions weighs 0.0765 lb., therefore,

$$\text{bmep} = \frac{1050}{\lambda \times f \times r_{th}} \frac{V_{\text{pure}}}{V_{disp}} \qquad (5)$$

It should be realized that V_{pure} is more than that part of the air delivered which is retained in the cylinder. It includes some pure air contained in the residual gas remaining in the cylinder from the previous cycle. Referring to Fig. 2 the following definitions and relations can be written:

$$\eta_{sc} = \frac{V_{ret}}{V_{ret} + V_{res}} \qquad (6)$$

$$\eta_{vol} = \frac{V_{ret} + V_{res}}{V_{disp}} \qquad (7)$$

$$\lambda = \frac{V_{\text{pure}}}{V_{theo}} = \frac{r}{r_{th}} \qquad (8)$$

$$V_{\text{pure}} = V_{ret} + V_{res} - V_{cp} \qquad (9)$$

$$\frac{V_{cp}}{V_{res}} = \frac{V_{theo}}{V_{ret}} \qquad (10)$$

In Equations (6) to (10) we have five unknowns: V_{pure}, V_{ret}, V_{res}, V_{cp}, and V_{theo}. These can be solved for V_{pure} for which we get

$$V_{\text{pure}} = V_{disp} \frac{\eta_{vol}\ \eta_{sc}}{1 + (\lambda - 1)\eta_{sc}} \qquad (11)$$

Equations (5) and (11) result in

$$\text{bmep} = \frac{1050}{f r_{th}} \frac{\eta_{vol}\ \eta_{sc}}{1 + (\lambda - 1)\eta_{sc}}, \qquad (12)$$

which can also be written as follows:

$$\text{bmep} = 180 \frac{0.4}{f} \frac{14.5}{r_{th}} \frac{\eta_{sc}}{1 + (\lambda - 1)\eta_{sc}} \eta_{vol} \qquad (1)$$

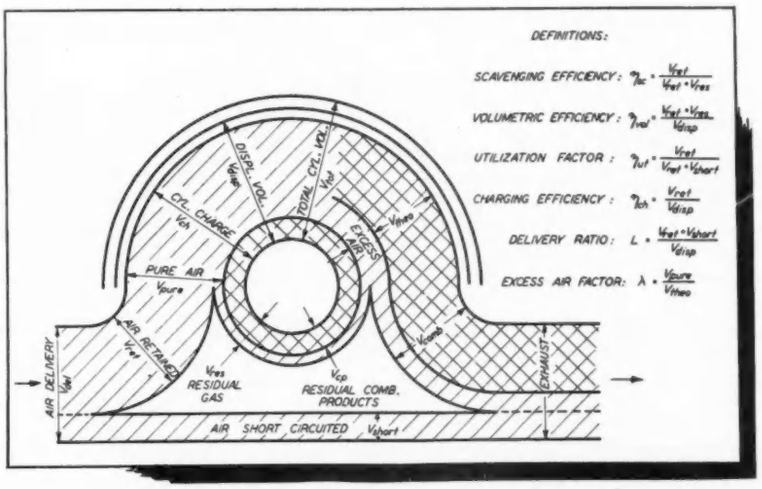


Fig. 2. Diagram showing the charging process of an internal combustion engine. The diagram represents either a two-stroke cycle engine or a four-stroke cycle engine with considerable valve overlap. In a four-stroke cycle engine without valve overlap, the air short circuited V_{short} is zero, and the area below the dash line is missing.

Russian

(Above) Caught in its own tank trap, this Russian unit was easily captured by the Germans.

(International)

(Above) This heavy Soviet tank was in the hands of the enemy when this photo was made.

(Press Association)

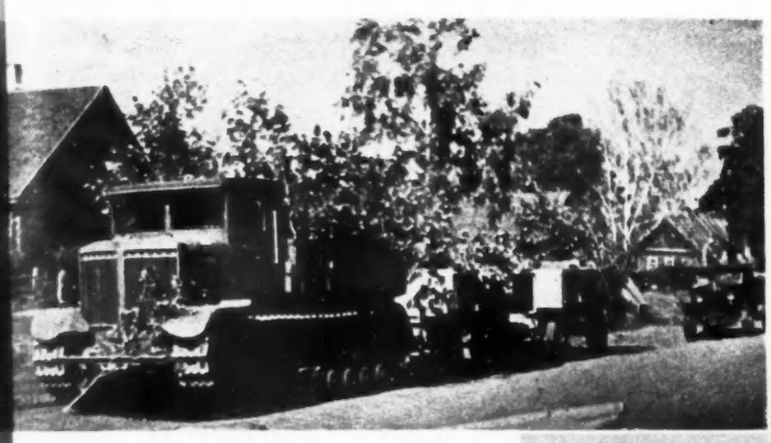
(Left) This light tank is being used by the Russian forces to reoccupy a village.

(Sovfoto)

(Bottom) A medium tank moving to attack.

(Sovfoto)

Mechanized Units on the Eastern Front



(Left) Large tractors with full tracks are being used behind the lines to move equipment.

(Sovfoto)

(Right) This trackless tank fell into the hands of the Germans.

(International)

(Below) Armored cars have an important part in Russian strategy. These cars are designed so that they can be converted to rail cars.

(Sovfoto)

(Bottom) Soviet amphibian tanks.

(Sovfoto)

The Influence of Automotive

Mass Production

on the manufacture of

War

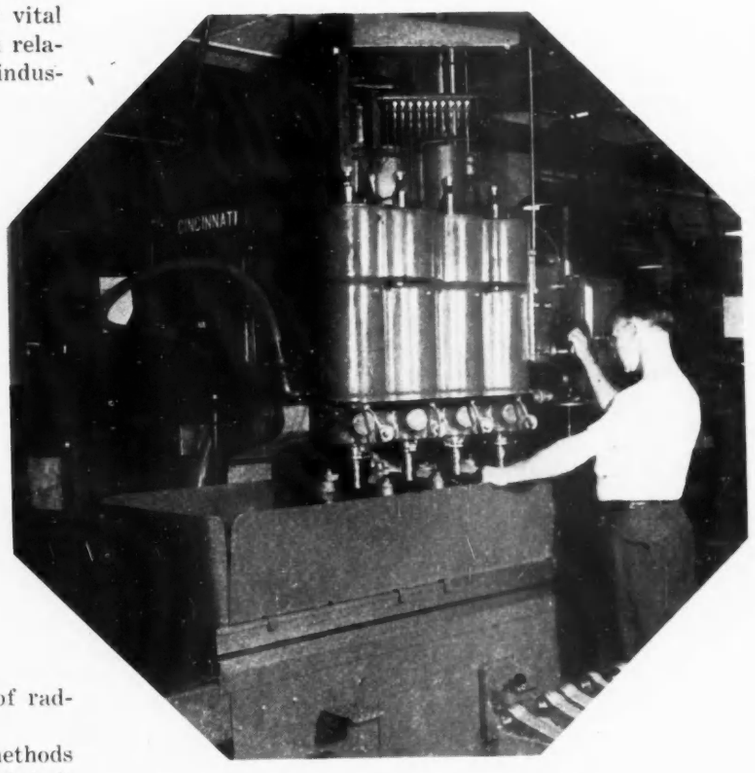
By Joseph Geschelin *

INITIAL stages of conversion by the automotive industry were represented by expansion of facilities, by the erection of new plants and the acquisition of entirely new equipment. Now the process has been extended to the utilization of the existing factory buildings, the using of available equipment supplemented with new machinery. Essentially the major contribution of the automotive industry is its "know-how." This has made it possible to place on a production basis the manufacture of the many vital things that heretofore were made by hand or in relatively small quantities. For over a decade the industry has been accelerating the tempo of mass-production techniques and originating unique processes which have made it possible to build better and faster, at constantly lower cost levels. But it has taken a grave war emergency to show the country how far reaching these accomplishments have been.

In appraising these advances, it is not sufficient to point to the achievement of mass production nor to the development of interchangeability on a vast scale. The real contribution lies much deeper. For example, in the process of perfecting advanced methods, the industry has encouraged the invention and manufacture of marvelous production machinery. This, in turn, has permitted a wholesale expansion of the basic machine tool industry. Too, there has been a parallel development of improved cutting tools, of improved foundry practice and forging practice, of radical procedures in the field of metallurgy.

The ramifications of modern production methods are so broad and take in so much territory that it would be quite difficult to touch upon individual examples in word pictures. Accordingly, a rather generalized perspective of the situation is presented here. It can be visualized best by reference to a large group of illustrations touching upon a variety of problems. Here is an outline of technical progress which constitutes the backbone of the wherewithall for making the weapons of war:

1. Machine tools—as a direct result of the needs of mass production, there was available the host of equipment so essential in defense production—precision boring machines, precision thread grinders, multiple-spindle drilling, tapping, and boring machines, precision grinders of every type, surface broaching machines, automatic lathes and turret lathes of various kinds, heavy duty precision milling machines, hydraulic presses, precision honing equipment, and so on.

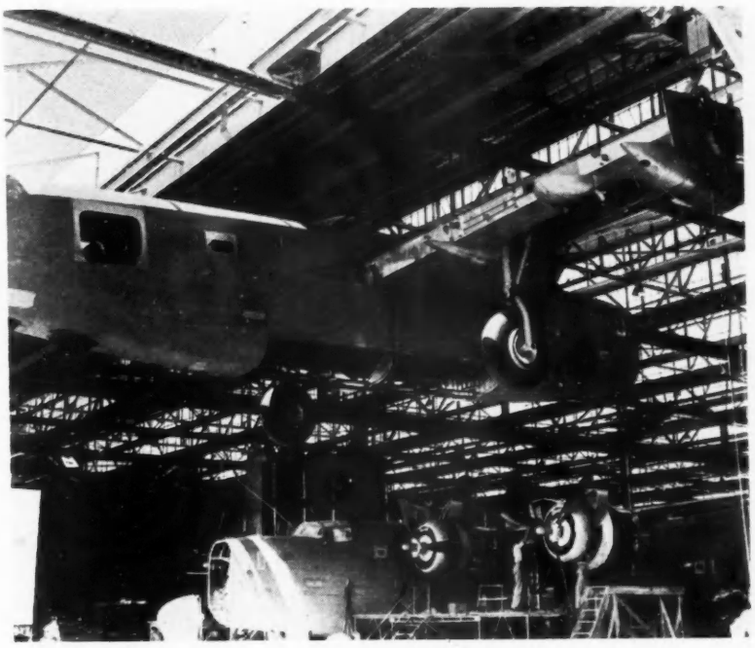


Familiar sight in airplane engine plants is this multiple-spindle Cincinnati Hydro-Tel miller. Some plants have these machines with as many as six spindles.

2. Metallurgy—because the automotive industry demanded and encouraged the development of the finest ferrous and non-ferrous metals possessing exceptional physical properties, durability, and good machinability, it has been possible to make the weapons of war more

* This article is an abstract of a paper prepared by Mr. Geschelin for the Society of Automotive Engineers.

Methods Materials



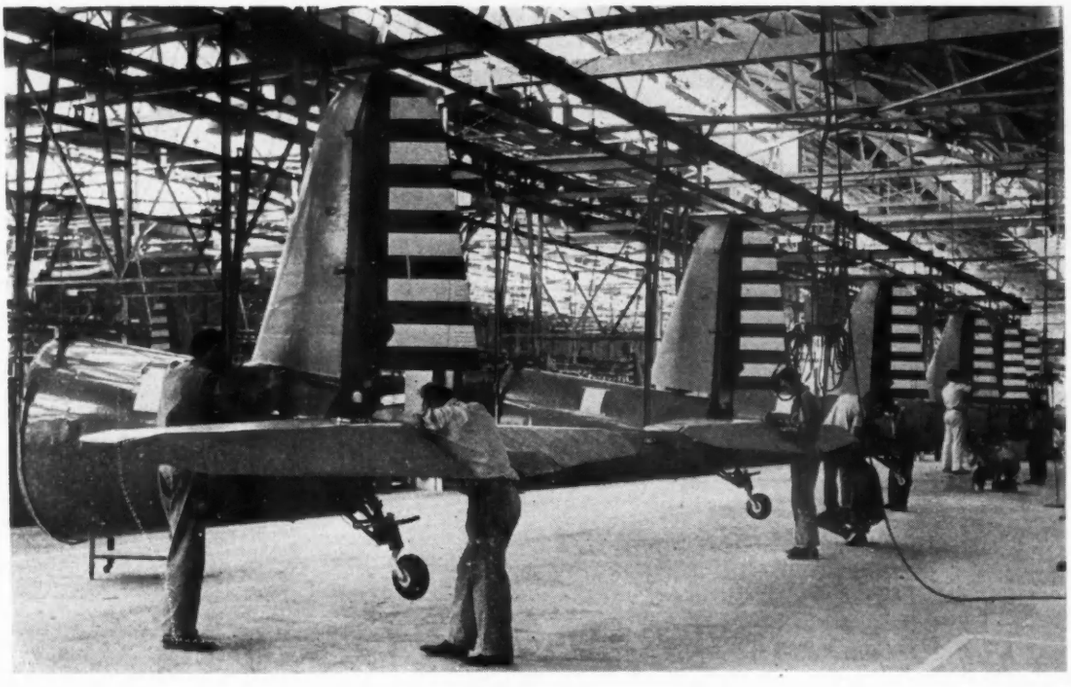
Big four-engined Consolidated bombers are toted out to final assembly stations on the overhead crane system.

powerful, more durable, and with mobility hitherto unknown.

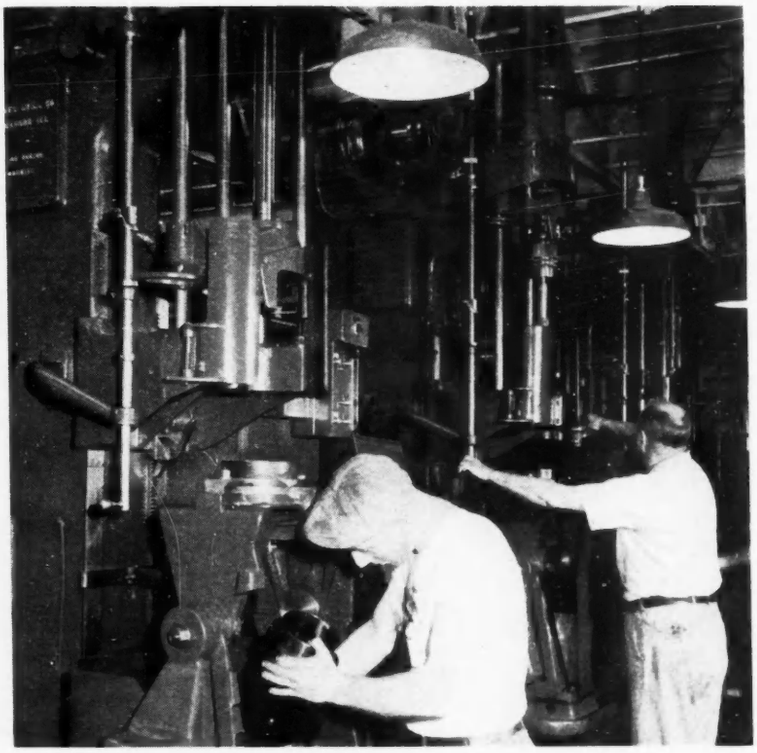
3. Materials Handling—mass production principles have developed the science of materials handling, have made available the conveyor systems, the power cranes and hoists, the industrial trucks, that are being exploited to the fullest extent in facilitating the flow of war products on the machine lines.

4. Surface finish—engineering talents and production techniques have been bent for a long time to the requirements of fine surface finishes for certain parts of the mechanism. This has been related to the wider uses of precision boring machines, precision grinders, honing machines, lapping machines, Superfinish equipment, etc. And it has been supplemented with instrumentation such as the Abbott Profilometer, the Brush Surface Analyzer, Magnaflux, P & W Electrolimit gage, Sheffield gages, etc.

5. Gear Practice—the requirements of "silent" gear trains, of durable gears of uncommonly small physical size, of long-lived highly stressed gears that have resulted in the availability of methods and equipment without which it would be almost impossible to produce the aircraft gearing in large volume. Improved methods of gear shaping and hobbing, shaving and lapping, precision grinding where needed, and allied techniques all contribute to the steady increase in the production of the finest aircraft gearing known to the art.



Tail assembly section, one of the highly mechanized departments in the Vultee plant, is typical of the conveyorized operations.



Battery of Barnes Drill Co. honing machines with Micromatic hones in Continental plant. Feature of this equipment is special work-holding fixture which can be tilted for examination and inspection of barrels without affecting alignment in machine.

6. Heat Treatment—high frequency induction hardening as exemplified by the Budd process, by Tocco, and by certain furnace manufacturers has greatly speeded the selective hardening of wearing surfaces. Infra-red baking lamps, now so widely employed for the rapid drying of paint, are being used at Air Cooled Motors to heat parts for interference fit assembly. Another modern technique is that of flame-hardening for selective surface hardening effects.

7. Shot Blasting to increase fatigue resistance—this method has been applied to axle shafts. Wherever the axle shaft is overloaded and an additional factor of safety is required, shot blasting has provided the means of extending shaft life. For years it has been employed in the finishing of the special disked clutch and coil spring. However, the recent shift to ferrous pistons at Buick has provided the setting for a wider use of this principle. Due to the added inertia loading, it was felt that the connecting rod would have to be strengthened. Instead of resorting to a heavier rod, with its attendant heavy expenditure for new die equipment, Buick switched to an alloy steel, supplemented with shot blasting. Through its use, it may be feasible to make parts smaller and lighter than indicated by mathematical analysis.

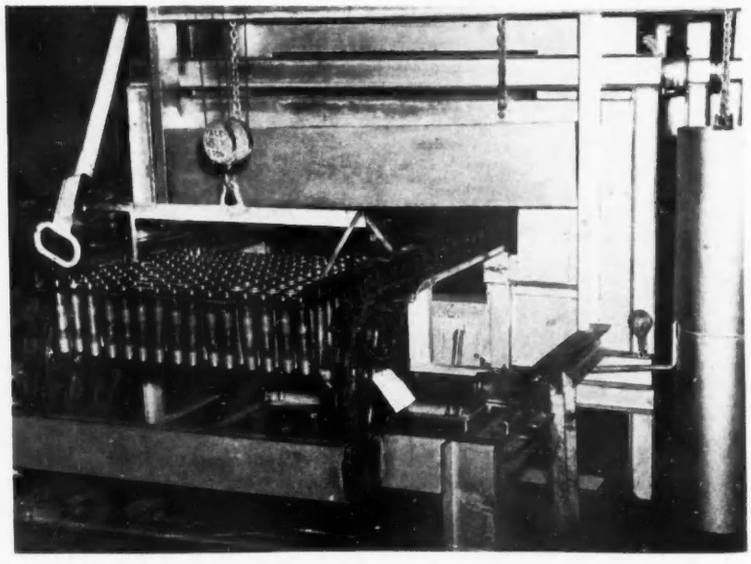
Leaving this generalized picture, the following are some actual examples of mass-production methods as used for making weapons of war.

Airplane Engines

Beyond a doubt the greatest influence of automotive production methods has been felt in placing aircraft engine building on a mass production basis. True enough, the leading engine builders in this field had many years of experience and had established standards for materials, for surface finish, for tolerance, etc. But the translation of these standards on a volume basis was entirely a new development.

Another type of production problem was presented with the entry of in-line liquid-cooled engines. Although in detail the in-line engine is subject to the same standards of manufacturing, it has numerous peculiarities quite foreign to the building of radials. As example of this, we may note the machining of long slender parts such as the cylinder head, crankcase sections, camshafts, crankshafts, and propeller shafts. Such parts demand special care in handling if the dimensional accuracy is to be preserved and if distortion is to be eliminated. For one thing, it means that the number of cuts and machine set-ups must be increased. This in turn requires more machinery, more fixtures, more rigid fixtures and tooling, more massive machines.

Generally speaking, one common characteristic of all aircraft engine building is that of extremely heavy chip removal. It is common practice to find that the ratio of rough casting or rough forging weight to the finished weight is of the order of five to one. Some

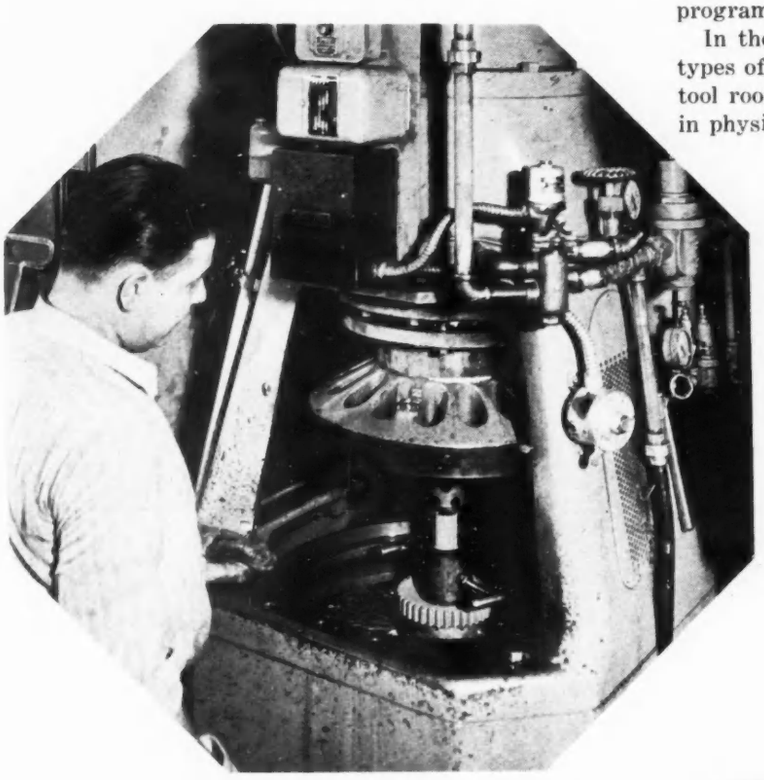


Electric Furnace Co., drawing furnace in use at Guide Lamp Div., for stress-relieving of small cartridge cases.

idea of the magnitude of the production problem may be gained from the following basic statistics on the Wright Cyclone 14:

1. The engine is composed of 3500 different parts, totaling 8500 individual pieces.

2. The estimated number of machining operations is placed at 80,000.



Gleason quenching machine is used for quenching all aircraft gears after heat treatment. This view taken at Allison plant.

3. The quality control program anticipates some 50,000 inspection operations.

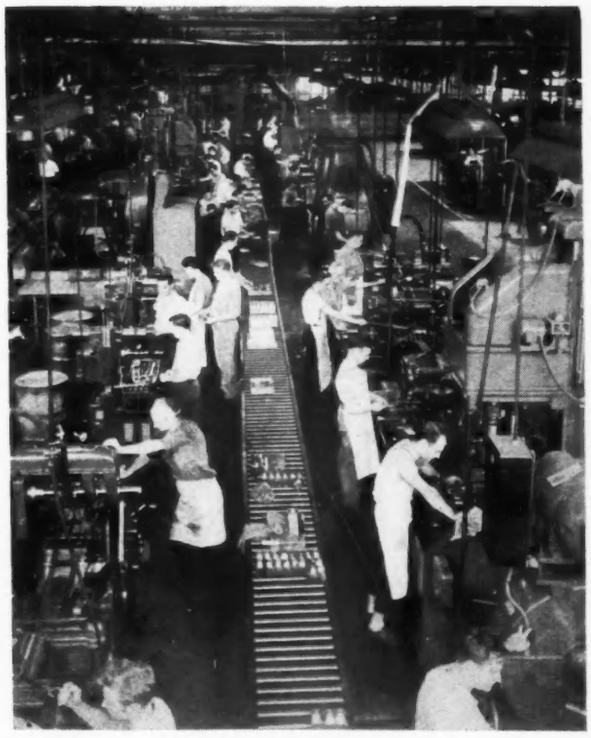
To handle this volume of machine shop activity just on the parts to be made in the Wright plant at Lockland entails the installation of 2400 machine tools of every description, including the most advanced equipment known to the art. Easily one of the most spectacular pieces of equipment is the fully automatic process machine developed by Greenlee for the machining of cylinder heads. With 14 heads per engine there is an opportunity to match the automaticity and productivity of the best examples to be found in passenger car practice. This is a special transfer machine for drilling, countersinking, reaming, and tapping. It is made up of two sections, extending about 80 ft. in length in a line-up of coordinated unit-type heads. It is estimated that this machine replaces about 40 machine tools of conventional type. The first unit of this Greenlee machine has 16 stations, taking some 25 different operations. The second unit has 57 stations, performs 46 operations.

Military Airplanes

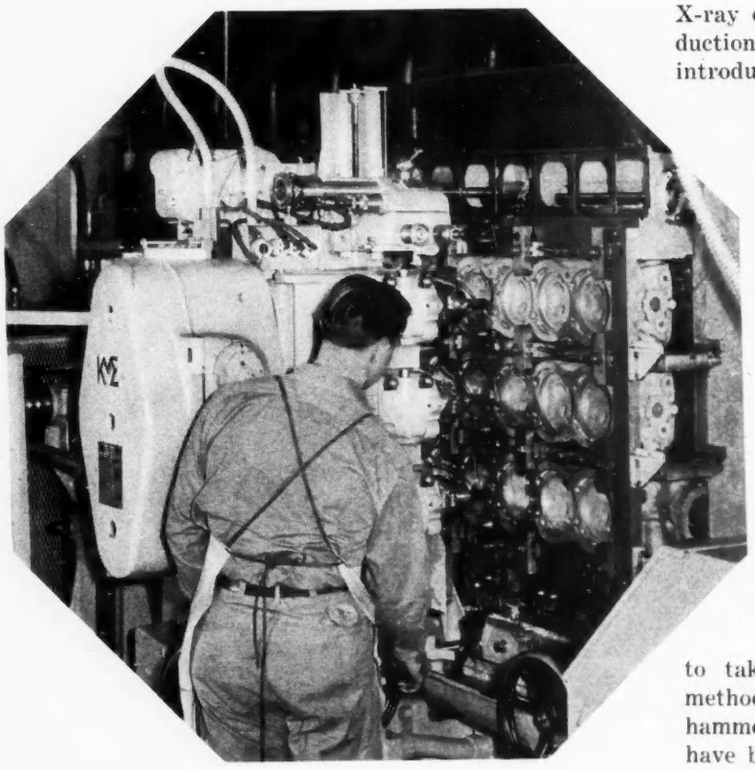
When it comes to the making of airplanes, that's the sphere of the specialists who have been at it since the last war. Nevertheless, it is obvious that the mass-production techniques evolved in the motor car industry have exerted a profound effect upon the manufacture of military airplanes. Doubtless much of this transfer of information came about through the medium of seasoned production men who cast their lot with the airplane industry at the start of the early defense program.

In the aircraft plants will be found the very latest types of familiar makes of metal cutting equipment in tool rooms and in machine shops, huge presses larger in physical sizes than most presses found in autobody plants albeit of lower pressures, latest types of water-back spray booths, large enough to accommodate the largest bomber without cramping.

When it comes to materials handling there are industrial trucks, monorail conveyors, cranes and hoists, floor conveyors —all of the tricks known to the art. But particularly impressive are the mechanized assembly conveyors. Airplanes are being assembled on moving conveyor lines with overhead monorail drops for engines, for complete fuselage sections, for wing sections, etc. Perhaps the most imposing of these is the assembly building for the Consolidated B-24 bombers, among the largest of the four-engined ships made in this country. The assembly building houses a U-shaped conveyor line 1500 ft. in length. The bomber starts with the



View of the bearing-cap line—one of many highly mechanized departments in the Packard Rolls-Royce operation.



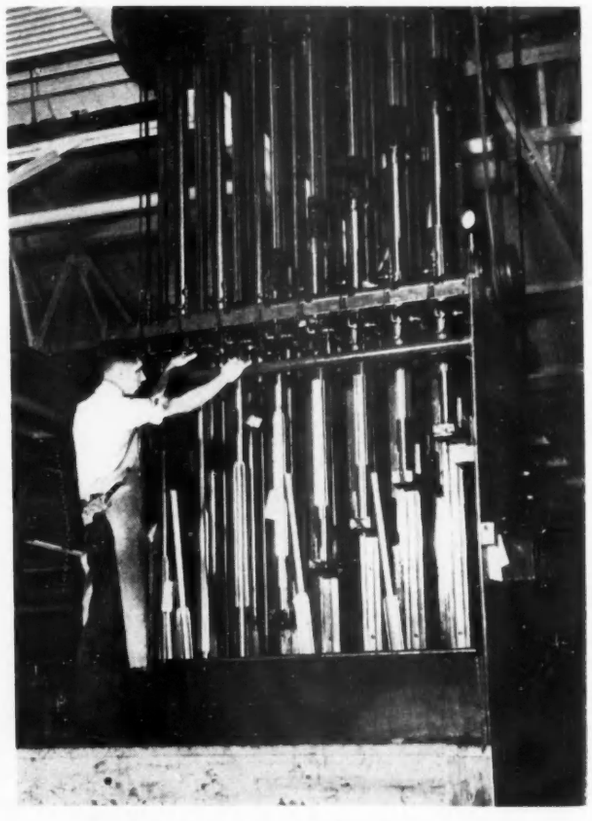
Well-known Keller die-sinking machine in use at Allison for contour-machining of cylinder heads, three at a time. Larger machines of same make are found at Aeroproducts in Dayton contouring propeller blade forging sections.

fuselage on one arm of the line, continues along 56 stations, winds up at the end of the other arm ready to take to the skies, after final touches, tune-up, and inspection.

Too, the airplane industry has developed new techniques which may prove to be of value to other industries. At Lockheed, a unique method for the rapid X-ray examination of castings on a really mass-production basis—20,000 pieces per day. At Douglas the introduction of the Guerin process of producing stampings with rubber dies. In others the development of fast and accurate methods of reproducing templates for stamped and formed parts by photo processes and by a new X-ray process.

The West Coast plants are proficient at welding, having had plenty of experience with the welding of aluminum and tubular structures. This was the proving ground for the remarkable Sciaky resistance welders. And today the largest batteries of these controlled cycle welders are found on the Coast. More recently these have been supplemented with specialized welders built by Federal, Acme, Taylor-Winfield, and others. Every trick of the welder's trade is employed—the oxy-acetylene torch, electric arc, spot welders, butt welders, seam welders.

Before the airplane producers were able to take advantage of mass-production press shop methods, every plant relied upon the use of the drop hammer. During the past year, drop hammer dies have been made of Kirksite, a special high zinc content alloy. Each plant owns and operates its own zinc foundry with from one to three large melting furnaces,



Eight-barrel W. F. & John Barnes vertical reaming machine is used in GM plant for rifle-reaming Oerlikon gun barrels. Earliest development along this line was six-cylinder drilling machine for gun barrels in GM.

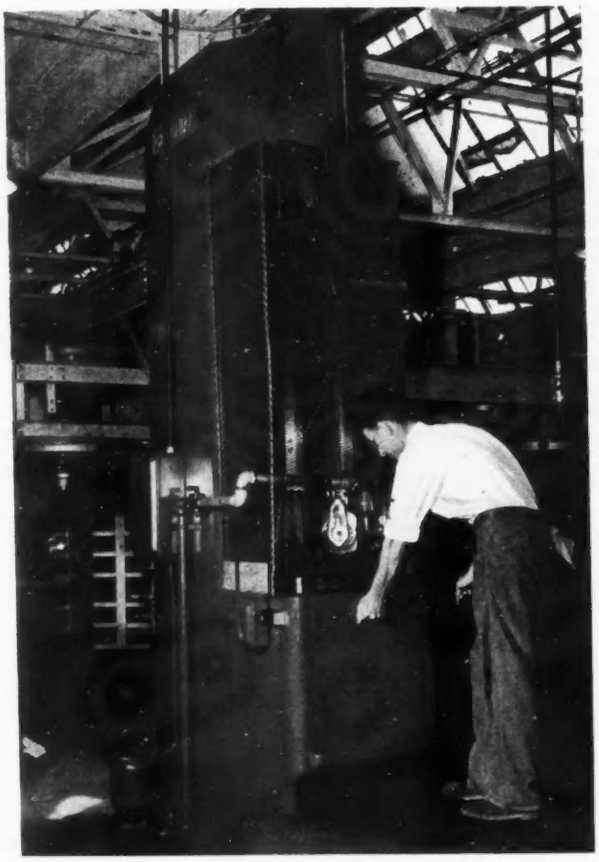
Schedules Ahead, Costs Down

HUNDREDS of examples now are coming to light how automotive production methods are contributing to the war effort by effecting substantial savings in cost and by advancing production schedules. Here are several of them.

An automatic gun cost about $1200 close to 18 months ago. After six months the cost was trimmed by over $250 and today's figure is almost 40 per cent less.

Using volume production technique with machine tools and fixtures, an automobile company has been able to reduce the time required for a bomber wing panel operation by 75 per cent. Another firm is 39 per cent ahead of schedule on a wing contract, 13 per cent ahead on a large wing section, and 20 per cent ahead on another contract.

On an important aircraft accessory there has been a price cut of 30 per cent since it reached large scale production, and the price for another is 44 per cent less.



Colonial surface broach at Continental is used for producing four flats on flange of cylinder barrel.

served by pattern shops, model shops, and provisions for making plaster forms for casting the dies. And a yearly consumption of thousands of tons of zinc metal, most of it reclaimed over and over again.

However, with the mounting tide of airplane production, we find the entry of huge drawing presses bearing names familiar in the automotive field — Clearing, Hamilton, Birdsboro, Bliss, Watson-Stillman, Hydraulic Press Mfg. Co., and others. The older drop hammers are giving way to the modern hydraulic press, although all of the available equipment will continue to be employed in the interest of getting the job done in a hurry. Several press shops boast large batteries of Chambersburg Cecostamp presses which constitute the most modern version of a sensitive but extremely powerful successor to the older drop hammer.

Another important newcomer in the field of metal stretching is the Erco "stretching press." Douglas and several others have installed this equipment recently. Instead of forming large skin panels in big presses with bulky dies, the aluminum sheet is stretched over a wood form. The ends of sheet are clamped in pneumatic holddowns on fixed tables flanking the center station of the machine, while bent loosely over the form. Then the center section is slowly inched upward to the end of a predetermined stroke, deforming the sheet into the desired contour. Fast and simple, it represents a major saving in time and expense.

One of the latest development along this line is a 150-ton metal stretching press placed on the market recently by the Hydraulic Press Mfg. Co. This is an unusually large machine, capable of stretching large panels of steel or aluminum for airplane sections and, in general, for many short run large sheet metal parts. The use of the H-P-M stretching press will expedite such operations by eliminating the use of large costly dies.

With the passing of time the airplane producers and their sub-contractors will be able to introduce still further refinements in production methods, in special techniques for conserving precious time. One recent development along this line is the widening use of the DuPont explosive rivet for blind fastenings. This has proved popular and valuable as a means of reducing the time for joining inaccessible sections, not only speeding up the assembly but materially reducing the cost and assuring a safer blind fastening.

Among the new production techniques at Lockheed is the Onsrud high cycle extrusion milling machine, developed for machining the ten long extrusions required for a single P-38 plane. Net result of the introduction of this method is a saving of three and one-half days of production time per ship. Prize exhibit in the press shop is a new Watson-Stillman hydraulic press of 4500-ton capacity.

Ordnance Materiel

When it comes to items like machine guns, anti-aircraft guns, shells, cartridge cases, etc., which are being made in quantities hitherto unknown, the pressure of volume and the production-wise experience of

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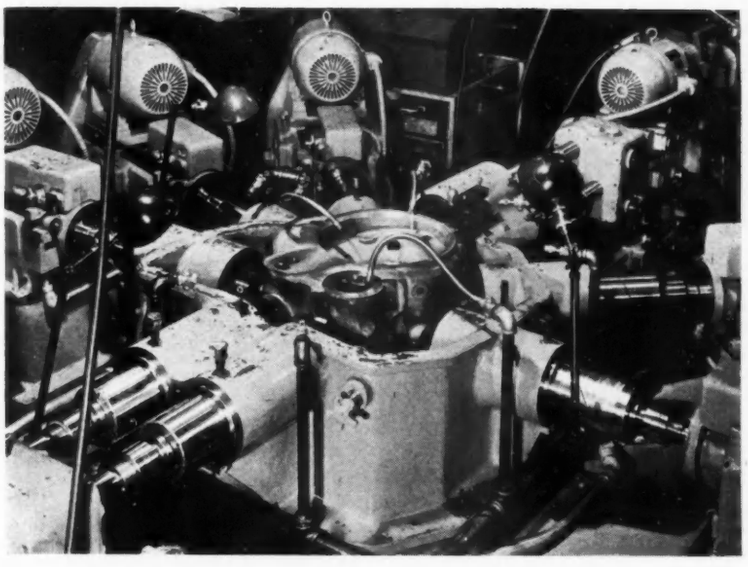


Special W. F. & John Barnes horizontal multiple-head drilling machine on Allison-engine blower section.

Plastic Drill Jigs a

MONTHS AGO when a scarcity of metals was impending, Lockheed and Vega began investigating the possibilities of using plastics to make certain types of tools and as the result of this development work both of these West Coast aircraft manufacturers now are producing drill jigs and forming dies of that material, which will stand up to 8000 psi under the hydropresses. Back of the research was the idea that drill jigs can be fabricated by securing the drill bushings to the master part, placing the part in a form and pouring a molding material around it. After the material has solidified, the bolts holding the bushings in position can be removed and the jig then is finished for use.

Another reason for the project was to overcome the disadvantages inherent in the current practice of constructing drill jigs of wood with inserted metal bushings. Creating a three-dimensional contour in wood is largely manual and the bushings often must be retained by steel nests or straps, which creates a layout problem and requires the extensive use of machine tools. Moisture and soluble lubricating oils also affect the wood adversely unless it receives surface treatment and periodic maintenance.

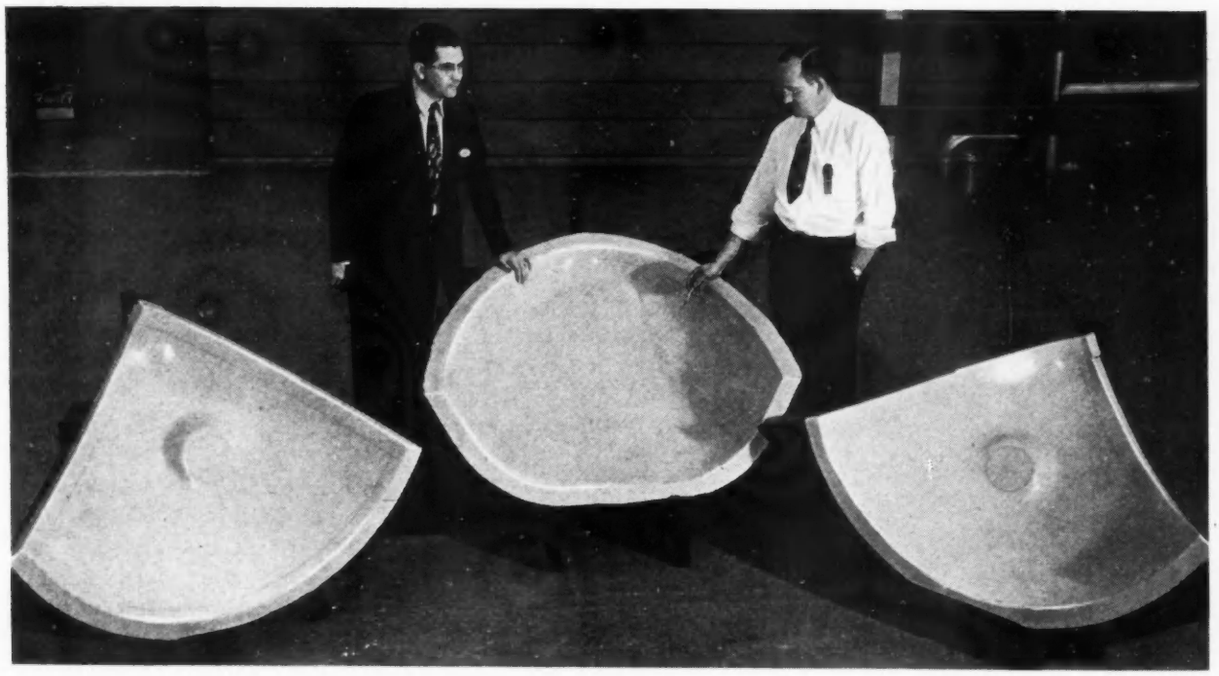
That the plastic material could be reclaimed cheaply was set up as a requirement and its properties had to be of such nature that it could be finished on standard wood working tools, its impact strength sufficient to withstand shop handling, brittleness avoided at low temperatures or after aging, and a resistant to lubricating oils and metallic ships formed in the drilling operations. In addition, means for controlling shrink of the molding materials must be available.

This investigation of Lockheed and Vega engineers in the plastic tooling field revealed several desirable features—that plastics may be substituted for steel and dural in many cases, that tools may be cast to a master part or plaster mold more quickly than by forming, milling or hand fitting, and that duplicate tools may be fabricated at less cost due to the fact that the molds are saved and at the same time this method expedites their shipment to the various company plants. As a plastic will not move under pressure, definite mold lines always will be maintained as long as 8000 psi pressure is not exceeded to form any kind of material.

The time factor—now a very important item to designers, planners, tool makers and others involved in tooling is one of the chief advantages. It is believed at Vega that the portion of their tooling program on the B-17F Flying Fortress, which has been completed through the use of plastics, involving three months' work, would have required five to six months if wood, dural and steel had been used.

This brings up another important feature. If templates or engineering data are not available, but a master part is available, then not only is time saved in making the actual tool, but there is eliminated the

Plastic die setup in a hydropress in the Vega sheet metal department.



These Vega forming dies are believed to be the largest phenolics on the West Coast.

and Forming Dies

for Aircraft Tooling

Pouring hot phenol acetone thermoplastic into mold at Lockheed plant for Lightning P-38 wing-root fairing drill jig.

time necessary to obtain this information and to make the templates. In this case the master part is used by building up the sides to allow for proper thickness of plastic and casting directly to the part. An exact reproduction of the contoured part is obtained by this method, thus eliminating machining, fitting to templates, and other operations. Techniques have been worked out to allow for part thickness when casting to a part, and to allow for part tolerances by making the casting oversize, even when casting to a master part.

For hydropress production tools, where a minimum of 1½ in. draw can be maintained, and by applying external beads as stiffeners around lightening holes in flat work, the application of plastic tooling helps speed up production by using two or more duplicate tools which cost little to manufacture and are light to handle. The development work can be done with a wood form block and a plaster split mold can be made to this wood form block. In this manner, duplicate tools may be cast out of plastics, the plaster split mold always being saved in event of breakdowns due to rough usage in production.

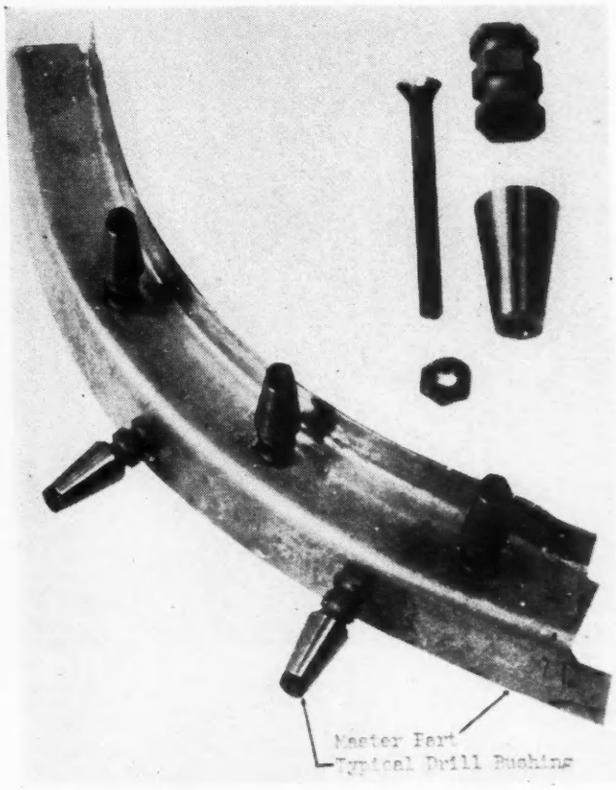


Fig. 1—Lockheed master part with drill bushings bolted to it. Insert shows drill housing, conical plug, nut and bolt.

Lockheed Technique

Of the several materials studied, Lockheed adopted a phenol acetone thermoplastic of special composition. For a satisfactory thermoplastic material, it was decided that the material should have a casting temperature of 225 to 325 deg. F. with a minimum softening point of 200 deg. F. These requirements would make it possible to cast a jig in an aluminum alloy part without damaging the latter and would avoid the danger of softening of the jig due to the heat generated by drilling. After experimental work a combination of a phenol acetone resin and a solid plasticizer resulted in a satisfactory blend. About 1½ per cent of maracaibo wax is added to make it inert to oil. The kettle for mixing the material is equipped with an agitator and is enclosed by a jacket containing a liquid bath for maintaining the proper temperature.

In using this special thermoplastic, molded drill jigs are fabricated from master part templates. The template contains master coordination holes as shown in Fig. 1. Drill bushings are bolted through the master co-ordination holes to the template. This assembly is then placed in a retaining form and the plastic material is cast over the part and around the drill bushings. Shrink is controlled by having the retaining form extend above the master part. Hence when the hot plastic first contacts the cold part, it solidifies rather rapidly, freezing to the contour. As the remaining plastic mass progressively solidifies, plastic is supplied from the reservoir created by the retainer, terminating in a sunken surface on top.

When the cast is cool, the retaining forms are removed and the concave free surface of the block is finished on the joiner until flat. Here the cone-like plugs (Fig. 1) are first removed, making the position of the drill bushings visible. A certain amount of care must be exercised at this point to prevent the joiner blades from striking the drill bushings. In practice the plastic is cut to within ¼ to 3/16 in. of the external drill bushing face and the hole to the drill bushing is chamfered as a finishing operation. Thermoplastic parts may not be sandpapered, as frictional heat causes gumming. However, a spoke shave or floor scraper will give an excellently finished surface.

To complete the jig, the part is placed between the drill plate and the next block (see Fig. 2) and the assembly clamped together. The alignment of the co-ordination holes in the part and the drill plate is checked by inserting the proper sized drill rod through the drill bushing and into the co-ordination holes of the part. This having been verified, the ⅜ in. holes are drilled through the ends of the assembled jig to accommodate the alignment bushing. The position of alignment bushing is shown in Fig. 3. The jig is then unclamped. The alignment bushings, which are serrated about their outer circumference, hold securely when driven into place. The alignment pins are then driven into the alignment bushings in the drill plate and held in place by heating a small amount of the plastic and flowing it into holes on the back of the drill plate.

Limit pins are driven into the drill plate at the ends of the master part, or may be placed through the part if it happens to contain pin holes used to locate the part during forming. In jigs of thermoplastic resin the position of drill bushings may be altered by "drifting". This is accomplished by in-

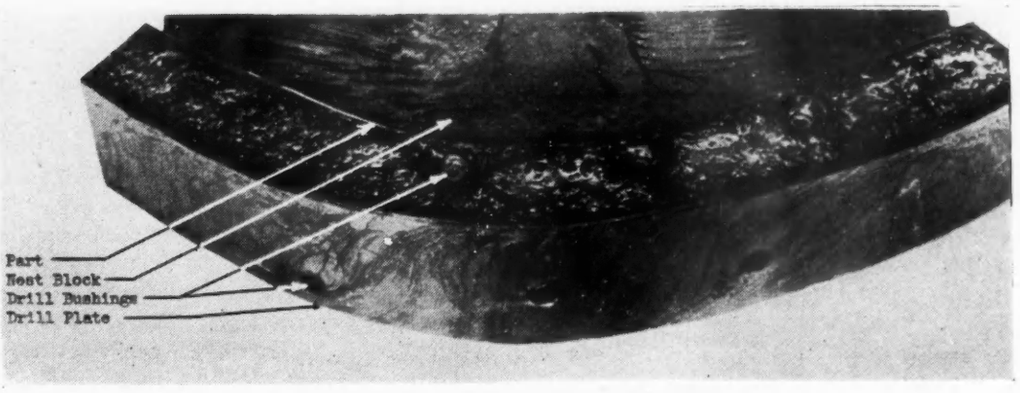


Fig. 2—Assembled plastic drill jig.

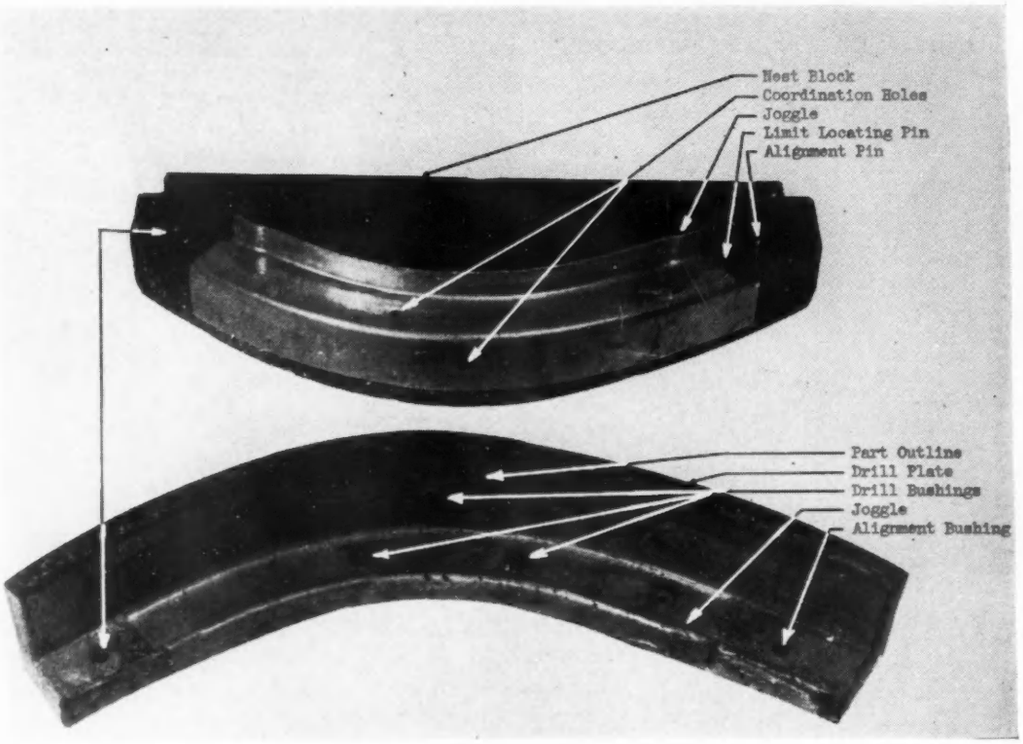


Fig. 3—Open plastic drill jig and part.

serting a torch heated drill rod in the bushing, allowing the heat to diffuse momentarily, then applying a force in the desired direction of movement. This will facilitate any alterations required by inspection.

If the part from which the drill jig is cast is extremely large, an alternative method of affixing the drill bushings is available. First the drill plate and next block are cast as outlined above, except that the drill bushings are not bolted to the master part. When the drill plate has been planed to the lengths of the drill bushing, the master part is nested and holes backdrilled through the template and drill plate. Using the pilot holes, enlarged to a diameter of one inch, affix the drill bushings to the master part, nest into the drill plate, clamp, and cast sufficient plastic around the bushings to bond them to the drill plate. Disassemble the bushings from the master part and finish as described in the preceding method.

After inspection the drill jig is ready for service and, given proper treatment, should prove satisfactory for innumerable parts. If the jig becomes damaged or obsolete, it may be returned to the plastic shop where facilities are available to salvage the plastic material and the metallic bushings and alignment accessories.

The Vega Development

Vega at present is using a thermo-setting phenol formaldehyde composition containing 25 to 30 per cent ground walnut shell flour as the filler. Other good fillers include wood flour, masonite and scrap plastic. By adding an acid catalyst to the base resin, the work is set up and finished in two to eight hours hours, depending upon the size. Former methods required three days to two weeks. Vega engineers found that this thermo-setting plastic applicable to drill jigs, formed router blocks, shaper blocks, saw jigs, checking fixtures, hydro-form blocks, dies, punch jigs, forming dies for plexiglass.

In cast phenolic drill jig plates bushings can not be cast directly in the drill plate. Locating the bushings, however, is accomplished quickly and efficiently by casting cerromatrix around the bushings which, in turn, are located to the master part or template by

This mold containing a thermo-setting plastic will be cured at 175 deg. F. in this Vega oven.

That plastic drill jigs are lighter and easier to handle than those made of steel or dural is the experience of Vega production men.

means of pins, oversize holes having been drilled in the plastic plate to accommodate the bushing and cerromatrix. These bushings are of sufficient wall thickness to eliminate the possibility of overheating.

These bushings, incidentally, are more quickly manufactured because of the fact that only the inside diameter is vital. On one drill jig that was made, there was a saving of $70.11 in the cost of bushings alone.

Vega's research and development division has outlined its technique for the practical application of plastics in the tool shop:

Molds for All Types of Bases

The advantages of plastic tooling are more pronounced in tools that require fitting to contours than straight surfaces. On formed router blocks, for instance, it is much more simple to make a form using the sample part as part of the form and cast a base, rather than blue it in and work it down by hand. There are two methods by which this mold can be made. One is to back up the part with clay or plaster and build the sides of the mold around the part, extending the flanges with plaster to allow a larger base or nesting block than the sample part itself.

Another method is to use the sample part as a pattern and make a complete mold from the part. On large castings it is often advisable to use the plaster from which the Kirksite die was made to obtain the contour. When this is done, a splash is made of the plaster, and the sides are built up of wood. It is better to use wood for the outside of molds whenever possible, because wood contains far less moisture than plaster and allows rapid penetration of heat. This insures a cured casting. In many cases the surface that is to be next to the part can be cast on plaster while the outer surfaces can be cast against wood and later sanded.

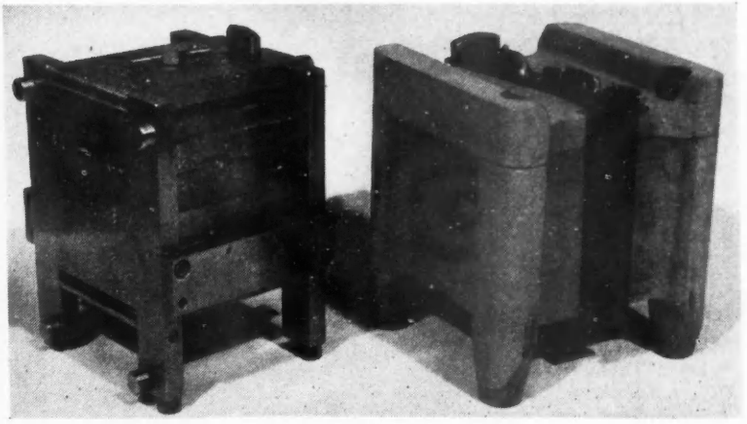
If plaster is to be used entirely for the mold, the volume of plaster should never exceed the volume of the casting. Mold thickness should always be kept to a minimum. The reason for keeping them thin is best explained by the action that takes place. When the reaction between the resin and the catalyst takes place, heat is created. The more volume we have in the casting, the more heat is formed. Thus, in a small casting, only a small amount of heat is created and the casting is forced to depend on oven heat to finish its cure. If a small casting is encased in a thick plaster mold, it takes oven heat some time to penetrate the plaster. Thus, in many cases, in order to cure the bottom of the casting, it would have to bake so long that the top, which is exposed, would be over-cooked. Molds of any material should be made in such a manner that they can be easily sprayed and then assembled and poured.

Treating the Molds

All plaster molds should be treated with one coat of Bayberry wax, let dry and sprayed with at least four coats of clear lacquer, sanding between the last two coats. The lacquer must be thoroughly dry before pouring with plastics. Wood molds should be coated with four coats of clear lacquer, sanding after the first one. The last coat should be absolutely smooth. Regardless of the material used in the mold, the casting will reflect every detail of the mold surface.

Drill Jigs

The above procedure outlined for molds holds true



(Left) Steel drill jig (right) new plastic drill jig to supersede the former.

for all types of jigs. Drill jig bases fall in the same category as formed router block bases. In many cases it is desirable to use plastic bases and some other form of drill plate.

As weight is an essential factor in all tools, bases should not be under ½ in. or over 2½ in. thick. On extreme contours, the bases should be made in the form of a shell. Bases should always be backed up with ½ in. masonite to absorb the jar in handling and protect the edges. In cases of a shell for a base, the shell may be fastened to the base at points of contact. When attaching wood or masonite to plastics, course threaded machine screws are recommended. Holes are drilled and tapped as in steel. Machine screws should be as long as possible.

When using a thermosetting plastic drill plate, never cast the bushings directly in the plastic. Cast the plate blank and back drill from the sample part of master part, locate the bushings and set in cerromatrix. One precaution is vitally important. When pouring the cerromatrix, be sure that it is not too hot, or it will expand and crack the plastic; 300 deg. F. is the proper temperature for pouring.

No design for plastics should include sharp corners or protruding angles or flanges that may be knocked off or chipped in use. All radii should be as large as is permissable on the particular tool. Outside radii that have no bearing on the function of the tool should be at least ⅜ in. Those may be sanded in some cases.

Wall thickness should always be ¾ in. or more. Drill plates that are poured with a constant wall thickness should be poured from one end, baked and left in the mold to cool. Thin sections poured from the flat side will warp.

Hold Downs

Any standard type of hold downs may be used, always bearing in mind the fact that when the clamps are closed or tight, the plate should be resting solidly against the base and yet not have the drill plate in a strain.

Drill Bushings

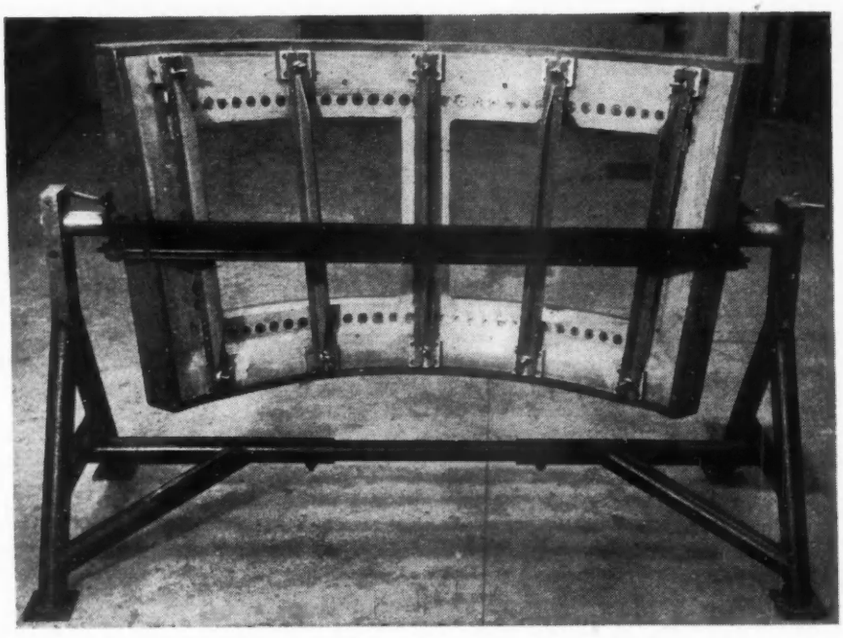
Plastic hex bushings are available and are recommended where space is not cramped. In the event that space is limited, use gang bushings.

Marking Plastic Jigs

Wherever possible, jigs should be stamped on the masonite base. When this is not convenient, and it is necessary to stamp the plastic, it should be done with a rubber stamp using India ink. When the final coat of lacquer is applied, which should be the last operation before inspection on all plastic tools, it seals the ink so that it cannot be rubbed off.

Plastic Form Blocks

All plastic hydro-form blocks should be mounted on a masonite base projecting all around the block ½ in. On blocks that are to be 2 in. high, the plastic should be poured 1½ in. thick. On thicker blocks, one in. Masonite should be used. Blocks should be standard 2-in., 3-in., and 4-in. If a wood pattern is made, it should be made to shrink scale. The shrink of the oil tool resin now being used is 1/10 in. to the foot. A plaster splash is made of this pattern and the splash used as a mold.



Plastic drill jig for pilot's escape hatch, backed up with mahogany wood frame to absorb shock of the drill motor.

Mixing the Resin

The mixing of the resin must be thorough. If the catalyst is not well mixed, there may be spots in the casting that will not set up. Also, if the fillers are mixed with the resin before the catalyst, the fillers will absorb some of the catalyst and form lumps of catalyst-filled filler that will not be mixed with the resin. For these reasons, it is better to first mix the resin and catalyst well, then mix in the fillers. The batch should then be thoroughly mixed and all the lumps beaten out of the fillers.

Excess plastic should always be poured (about ¼ in. on large castings and ⅛ in. on the small ones) to allow for surfacing off the bubbles that will rise to the surface. Castings should be allowed to set outside the oven for at least ½ hr. before baking to allow the air bubbles to rise to the surface. Here are a few "Don'ts" that are the results of eperience and experiment: (a) Don't lacquer a hot object; (b) don't use aluminum lacquer to coat a mold; (c) don't

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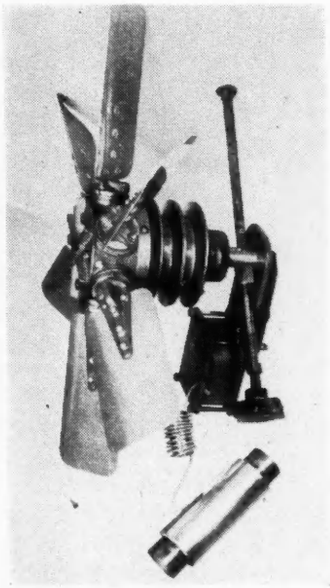
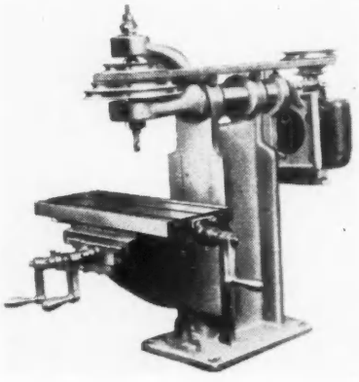


This variable-pitch Kontrol-Fan is designed for installation on industrial internal combustion engines. *(Described on page 44)*

NEVER before has it been so necessary to produce vital materials at such a scorching pace. Production men, ever alert to the need for greater efficiency, are developing methods to cope with new problems. Because much-needed equipment is unavailable, because new processes cannot be initiated overnight, many machines are being used to "hog out" materials almost as hard as the tool bit itself, others are producing pieces for which they were never designed. As a consequence, maintenance costs soar, tool breakage mounts. In perusing these pages the reader may find the very machine for the job, the solution to a baffling problem. Designers and researchers, too, are creating new machines, new products, and new materials, all of which can contribute their part toward more efficient quality output.

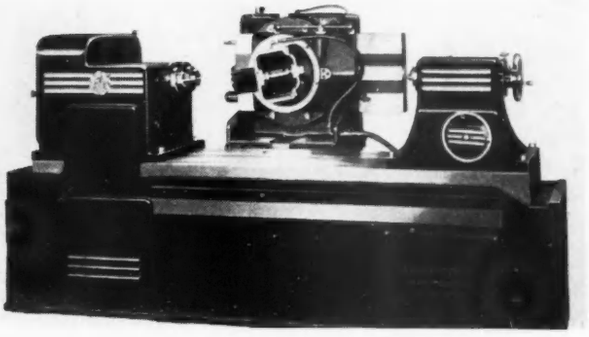
DEVELOPED for use in the tool room and on the production line, a vertical milling machine, built by the Duro Mfg. Co., Los Angeles, Cal., provides spindle speeds of 450, 850, 1400, and 2100 rpm. Splined disengageable handles operate micrometer adjustments for each movement of the table which has a vertical travel of 7 in., a longitudinal travel of 8 in., and a transverse travel of 5 in. The one-piece spindle support of the Duro Mill is equipped with a graduated dial and index pin allowing adjustments to 60 degrees each side of center.



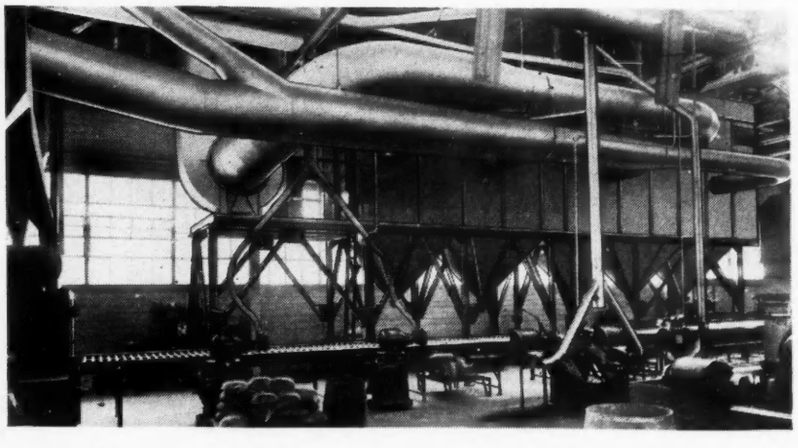
Duro vertical milling machine.

CAPABLE of handling gears up to 36 in. in diameter, a new rotary gear shaver utilizing the crossed-axis principle of gear finishing is now being produced by the Michigan Tool Co., Detroit. The new shaver is similar in general design to the 865-48A announced recently and is designated as the 865-36A. As on the larger machine, work on the 865-36A is driven; consequently, the cutter follows the gear. The machine is equipped with two driving spindles.

Three methods of finishing gears are available in the new machine. In the first method, particularly suited to finishing of wide face gears, the cutter in addition to having an infeed toward the gear is also reciprocated parallel to the axis of the gear. In the second method, used for quick finishing of gears having a narrower face width than the cutter, the slide is set vertically. The cutter, however, bears the same relationship to the gear as in the first method. The third method represents a combination of the first and second methods. The cutter slide is again vertical, but infeed is used, the cutter head reciprocating vertically instead of horizontally as in the first method. By this method the gear is finished by a number of vertical "passes" instead of one as in the second method.



This new Michigan gear shaver employs the crossed-axis principle of gear generation.



Dust collector equipment built by American Foundry and Equipment Co.

MAINTAINING that dust is a serious menace to safety and health, the American Foundry and Equipment Co., Mishawaka, Ind., is stressing the need for dust-collecting installations in all

MACHINES

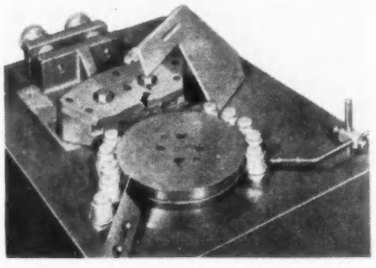
points where dust concentration exceeds recognized safe limits. The equipment shown in the accompanying illustration is being used in the casting-grinding room of a large aircraft engine factory. Dust is carried through the various ducts which lead from grinders to the American Dustube cloth-bag-type dust collector.

THE Matthews No. 201 fuse marking machine, manufactured by Jas. H. Matthews & Co., Pittsburgh, Pa., is capable of marking virtually all sizes and shapes of fuses. Driven by a 1/3-hp explosion-proof motor running on 220 or 440 volts, the marker is said to turn out between 100 and 125 pieces per minute.

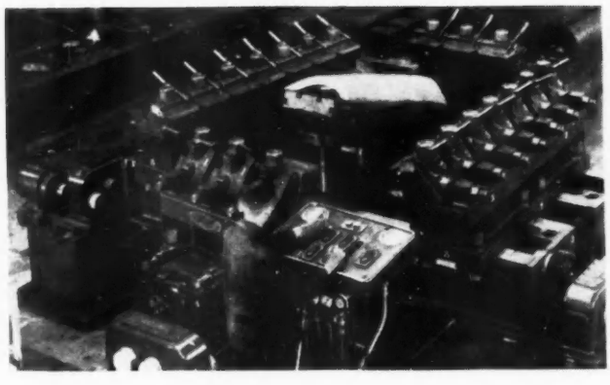
THE HPM Fastraverse self-contained forging press, according to its manufacturer, The Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, presents a more favorable means of high-speed production than the older steam-hydraulic presses. Claiming reduced first cost, lower maintenance and operating charges, and greater production efficiency, the company notes the absence of any auxiliary equipment, the lack of trouble from steam-worn high-presure packing, and the almost complete elimination of pressure losses.

well as to the tailstock. The movement of the tailstock is controlled by a hand-operated valve, and facilitates loading and unloading of the piece by pushing it forward into the center-drive fixture.

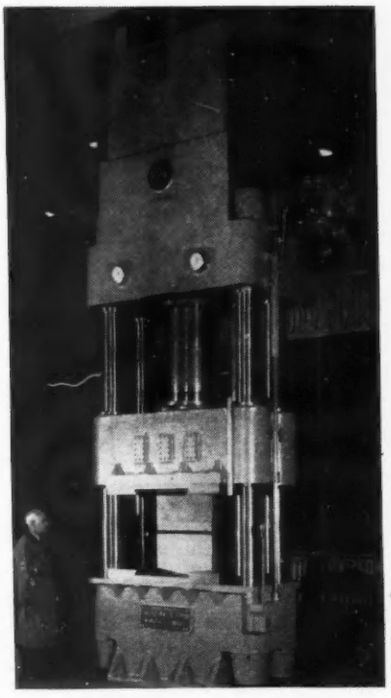
The control of the entire machine consists of a start-and-stop push-button, a cycle-start push-button and an emergency return. The headstock,



Designed especially for fuse marking, this Matthews machine incorporates a concave die against which the fuse is forced by a rotating pressure table.



Close-up view of the remote control desk of the Bristol Aeroplane Co.'s new stretching press, showing how the platen table, if desired, can be tilted by the rams, one at each side of a central swivelling support.



HPM Fastraverse self-contained forging press.

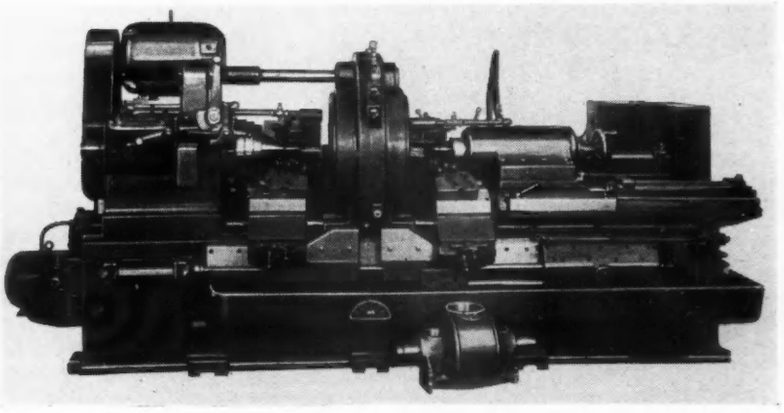
which is equipped with a twin-plate friction clutch between the motor drive and the spindle, contains an oil pump for pressure lubrication. The center-drive is lubricated by the main drive gear which is fed from an oil reservoir.

SUPPLEMENTING a number of sheet-metal-stretching machines previously acquired, the Bristol Aeroplane Co., England, has had installed recently the first of a new type, built by a British firm, Fielding and Platt. It has a fabricated frame of welded construction, although castings are employed for some of the components. There are four sets of grippers, two main or side sets of seven units each, and two auxiliary or end sets, each formed of three units. The grippers are all hand-operated as specified by Bristol, though pneumatic operation is available if required.

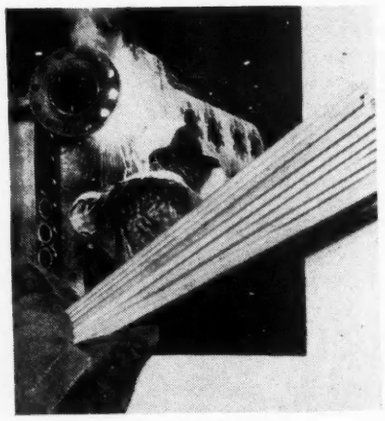
Although each set of grippers is mounted on a crosshead and normally

A PRODUCTION increase of 65 per cent through the use of its hydraulic turning machine in a particular operation is claimed by the Snyder Tool and Engineering Co., Detroit.

A feature of this machine is the hydraulic feed operated from a single hydraulic power unit in the rear of the machine. This unit furnishes power to both front and rear tool slides as



Snyder heavy-duty hydraulic turning machine.



This new General Electric all-position a-c welding electrode makes it possible to work in places where d-c welding was formerly necessary.

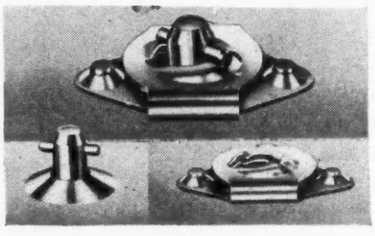
slides as a unit on machined guides, an independent adjustment is provided for every gripper of all sets. Furthermore, any set of grippers can be arranged at an angle to the platen by appropriate use of the remote controls; in the case of the side sets, this type of setting is effected by two screws operated independently through reduction gears by a 4½-hp motor.

The platen table is supported by two hydraulic rams, one at each end, and between them is a central guide with a swivel mounting. By this means either end of the table and platen can be raised or lowered about the swivel mounting to permit progressive "working" of the metal sheet when and where this is necessary as a preliminary to direct vertical movement of the die.

Control of the movement of the rams and of the motors is gained from an operating "desk." Each ram has a stop to prevent it from being driven out of its cylinder, limit switches are provided to avoid over-running of the gripper screws, and similar provision is arranged to control the angular adjustment of the gripper crossheads.

Two mono-radial pumps are included in the hydraulic equipment, each giving an output of either 6 gpm at 300 psi, or 0.6 gpm at 4500 psi when running at 940 rpm. A 25-gal tank is provided for the feed of the pumps, each of which is driven by a 3-hp motor.

The machine can be arranged for use as press for flanging and similar operations, or for recessing and other counter-forming work. Adaptation to these operations is effected by the use of an overhead table on four columns, for which sockets are provided at the ends of the guides of the side-gripper crossheads.



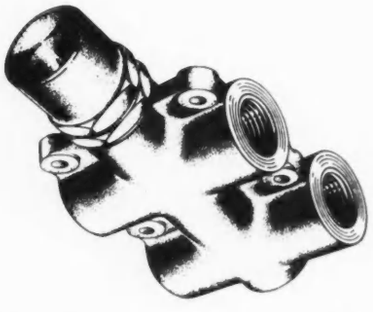
Shakeproof cowl fastener for attaching cowling and other removable aircraft parts.

To answer the need of aircraft manufacturers for a quick, efficient method of attaching cowling and other removable parts, the Aviation Division of Shakeproof, Inc., Chicago, has introduced a cowl fastener of simplified design.

A standard fastener assembly consists of three parts: a main spring, a stud and a cross pin; only two special tools are required for its application. To install the fastener, the main spring is riveted in place over a drilled or punched hole in the inner sheet, the stud member is inserted in a matching clearance hole in the outer sheet, and then the cross pin is press-fitted in the stud with special pliers. A clockwise quarter turn pulls the parts together and locks the stud in two detents in the main spring. Studs can be furnished with either slotted or wing heads.

The fasteners are manufactured in two sizes to conform to AN strength classifications 5 and 7 (up to 500 and 700 lb, respectively), and with flush oval, or wing heads. Standard units are available to accommodate total material thickness ranging from 0.035 to 0.254 in.

Adel precision products corp., Burbank, Cal., has announced a new noiseless relief valve for aircraft hydraulic systems. Conforming to A. C.



This newly-designed Adel hydraulic relief valve is claimed to be extremely quiet in operation.

Specifications 27993, the valve is said to be constantly positive in action at any adjusted setting. The aluminum alloy body, fitted with internal ports incorporating the basic Adel design, provides an extremely light unit.

Manufactured in sizes A-4 at 1 gpm, A-6 at 3½ gpm, A-8 at 5 gpm, and A-10 at 8 gpm, the valve can be furnished in pressure ranges from 600 to 2200 psi as governed by specifications. Port sizes, threads and fittings can be supplied in either AN 10050 specifications with synthetic rubber seals, or AC27993 specifications with serrated port and crush seals.

An all-position, high-quality alternating-current electrode, Type W-26, extending the advantages and convenience of a-c welding to both vertical and overhead positions, has been announced by the General Electric Co., Schnectady, N. Y. The new electrode, which conforms to the requirements of many standard specifications, is said to provide a strong, forceful arc having good fusion, excellent penetration, and uniform characteristics free from arc blow. It is now available in ⅛ in. and 5/32 in. diameters; other sizes from 1/16 in. to ¼ in. are expected to be available shortly.

Designed to speed production of plywood planes and sub-assemblies, the Boots self-locking "cage" nut, manufactured by the Boots Aircraft Nut Corp., New Canaan, Conn., provides a permanent fastening for both plywood and plastics. Clinched in position by the tool shown in the photograph, the nut may be applied to sheets ranging in thickness from ⅛ to ½ in.

A NEW variable-pitch cooling fan, developed primarily for the accurate control of cooling water temperatures in industrial internal combustion engines, has been announced by Kontrol-Fan, Inc., Los Angeles, Cal. Entirely automatic in operation, the Kontrol-Fan blade assemblies function similarly to variable-pitch aircraft propellers; blades feather from almost zero pitch to a maximum of 38 degrees. The blade angle is controlled by means of a simple lever arrangement which is in turn operated by a sylphon bellows placed in the cooling system between the cylinder head and the top of the radiator. The fan is said to effect economies in oil consumption and engine repairs, and to reduce the power absorbed by the fan under light-load operation. (Illustrated on page 42.)

Because aluminum and magnesium are sensitive metals which, when carelessly handled, become pitted, etched, or discolored during cleaning in harsh alkaline solutions, Oakite Products, Inc., New York, N. Y., has an-

(*Turn to page* 80, *please*)

Industry Approaches Limit of Conversion

Subcontracting, New Ideas Boost Output Beyond Schedule; War Reports Praise Performance of Industry's Products

Conversion and retooling of the automotive industry from that of a peacetime producer to the volume output of armaments is nearing its conclusion. Of course, retooling still will continue on war products as design changes dictated by combat conditions and military strategy as well as improved manufacturing techniques make that necessary. This is exemplified by the transition from the M-3 medium tank with its riveted hull to the more streamlined M-4 model with an all-welded hull. The latter is more impervious to enemy gunfire and can be manufactured in a shorter time. Similar conditions have prompted the Air Corps to discontinue production of one type of bomber now being manufactured in several Detroit body plants. These facilities later will be taken over by an order for late model fighter planes. This will necessitate certain retooling. Another similar change was the redesign of military trucks as the result of experience learned on maneuvers, with the new models having a low silhouette and a resultant lower center of gravity, with less likelihood of turning over while negotiating rough terrain.

Volume production has been reached by certain automotive plants producing shell cases, army trucks, jeeps, anti-aircraft guns, airplane engines, tanks, machine guns, and marine engines. But these plants had received their initial orders six to 18 months before Pearl Harbor and thus had tooled up for these jobs while automobile production still was in progress. Now the plants which received their orders after Pearl Harbor are nearing or getting into the mass production stage. Longest tooling up was required by the bomber airframe program undertaken by the old Automotive Council for Air Defense. Due to the different techniques involved, the complexity of the product to be manufactured, and the frequent design changes required by experience under air combat conditions, the period was lengthened. But now most of the problems have been mastered and the bomber subassemblies are beginning to flow from Fisher Body, Ford, and Chrysler to the government-built assembly planes in the Midwest and Southwest.

Rep. R. Ewing Thomason, Texas Democrat, recently told the House of Representatives that the automobile industry is 98 per cent converted to war production, after he and his fellow members of the House Military Affairs Committee had made a tour of war plants in the Detroit area, including the Ford Willow Run bomber plant. According to reliable estimate, the erstwhile automobile industry produced $350,000,000 worth of war materials during June. Alfred P. Sloan, Jr., chairman of General Motors, recently announced that GM was delivering war goods at a rate of $5 million daily, which on a monthly basis would be $150,000,000. This is a gain of 34 per cent over April war output of $112,000,000 by GM plants.

Current restrictive factors to a

(*Please turn to page* 54)

RFC Authorizes Building of Pilot Plant

Dow Chemical Co. has received a letter of intent from the RFC for construction of a "pilot plant" to manufacture Thiokol, a chemical compound developed by Dow and the Thiokol Co., of Trenton, N. J. Materials and equipment for the new plant have been given a high priority rating, according to the War Production Board. The plant will produce enough Thiokol to retread 500,000 passenger car tires per year.

Ethylene dichloride is the limiting factor in the production of Thiokol. Even if the pilot plant is a success, only enough ethylene dichloride is available for annual Thiokol output sufficient to retread 800,000 tires. Expansion of facilities for producing ethylene dichloride probably would not be approved by the WPB.

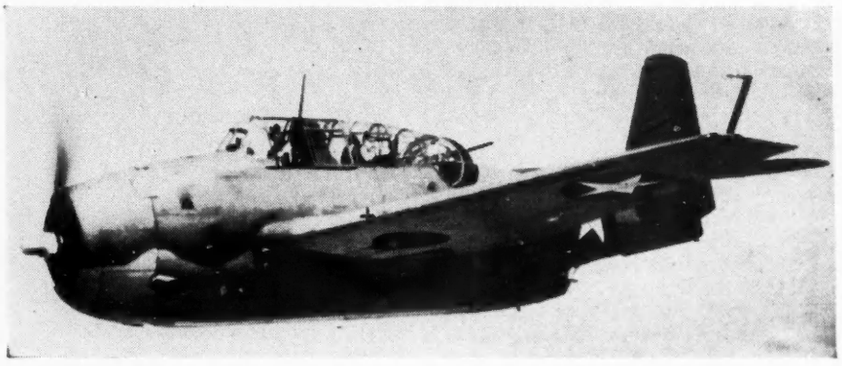
Wood Bodies Save Steel

Conservation of approximately 275,000 tons of steel annually—enough to build 30 large cargo ships—is expected from a new Army policy of prescribing wooden bodies instead of steel on all cargo trucks of 1½-ton size and larger, the War Department announced recently.

It Still Runs, But Not on Gasoline

According to published estimates, this type of trailer-carried gas-producer, burning activated anthracite, permits a bus to run 100 miles without refuelling, and to save approximately 8750 gallons of gasoline per bus per year. The unit shown is being used experimentally on London busses.

Acme



Grumman "Avenger," Navy's Newest Torpedo Bomber

The Navy has announced that the new Grumman "Avenger," a ship-based torpedo-bomber, received the baptism of fire in the recent Midway Island engagement. Equipped to carry either a ton of bombs or one regulation torpedo, the plane has a top speed "in excess of 270 mph," a range of 1400 miles, and a service ceiling of 20,000 ft. Carrying a three-man crew, it bears a resemblance to its smaller cousin, the Grumman "Wildcat" fighter. Although other torpedo-bombers mount torpedoes in exposed cradles, the Avenger's new design permits the total concealment of the torpedo within a compartment in the fuselage.

Los Angeles Scene of Aircraft Wage Conference

First of Six Wage Conferences Scheduled for July 6; Unions Given Varying Support in Scattered Balloting

First of a series of wage stabilization conferences in the aircraft industry will be held July 6 at Los Angeles. Representatives of nine airframe manufacturers on the Pacific Coast will meet with labor leaders from the UAW-CIO and the International Association of Machinists (AFL), along with officials from the War and Navy departments. Paul R. Porter, newly appointed chief of the Wage Stabilization Branch of the Labor Production Division, WPB, will preside at the conference.

Objectives of the conference, according to Wendell Lund, director of the Labor Production Division, are to develop a stable labor force by minimizing labor turnover, cutting down worker migration, and facilitating training of new employes; to stabilize wages at a level designed to check inflationary tendencies in a war economy, and to maintain present sound labor relations in the industry. Douglas Aircraft Co., Inc., recently offered its workers a 10-cent-per-hour raise, subject to government approval, and Vultee Aircraft, Inc., proposed a 7-cent-an-hour raise, but both these increases were held in abeyance pending wage stabilization for the entire industry on the West Coast.

The recent Chicago Shipbuilding Stabilization Conference, at which the shipbuilding unions agreed to take wage adjustments in war savings bonds, is regarded as a model for the aircraft session. Decisions at that conference were reached on a voluntary basis. An indication of the demands of the UAW-CIO in the aircraft industry was given recently by Richard T. Frankensteen, aviation director of that union. He said the UAW-CIO would demand that wages in aircraft plants be raised to the level paid in the automobile industry. Last December the average hourly rate in aviation plants was 90.2 cents compared to $1.16 in the automobile industry, according to Frankensteen. The shipbuilding rate was $1.13, resulting in a shift of workers from West Coast aircraft to shipbuilding employment.

The UAW-CIO has met varying success in recent NLRB polls in the aircraft industry. Independent unions triumphed over the UAW-CIO in two large aircraft establishments. In five plants of the Wright Aeronautical Corp. at Paterson, N. J., the Wright Aeronautical Employes' Association polled 9713 votes, or 62 per cent of those cast, while the UAW-CIO received 5623. At the Allison Division of General Motors, employing upwards of 10,000 workers, the United Aircraft Engine Workers gained 59 per cent of the votes and the UAW-CIO received 38 per cent. However, the NLRB has outlawed two independent unions in plants of the Curtiss-Wright Corp. for allegedly being company-dominated. It has ordered withdrawal of recognition to Propeller Craft, Inc., in plants at Clifton and Caldwell, N. J., and to The Aircraft at Buffalo. At the latter plant the International Association of Machinists (AFL) is demanding a 5 per cent wage raise under a contract signed last December with The Aircraft, which

(*Please turn to page* 71)

House Appropriates Sum For Guayule Production

The Appropriation Committee of the House of Representatives on June 16 voted a sum of $8,835,000 for renting and working 50,000 acres that are to be planted with guayule seed for the production of rubber. At present, nurseries covering 500 acres are growing guayule for seed and for the experimental extraction of rubber. The appropriation just made evidently will permit of multiplying guayule cultivation in the United States a hundredfold.

ASME Nominates Officers

Nominations for 1943 officers of The American Society of Mechanical Engineers were announced recently. Election will be held by letter ballot of the entire membership of 16,000 closing on September 22, 1942. The nominees as presented by the Committee are:

President, Harold V. Coes, Vice-President, Ford, Bacon & Davis, Inc., New York, N. Y. Vice-Presidents, Joseph W. Eshelman, President, Eshelman & Potter, Birmingham, Ala.; Thomas E. Purcell, General Supt., Power Stations, Duquesne Light Co., Pittsburgh, Pa.; Guy T. Shoemaker, Vice-President, Kansas City Light & Power Co., Kansas City, Mo.; Walter J. Wohlenberg, Professor, Mechanical Engineering, Yale University, New Haven, Conn. Managers, Roscoe W. Morton, Professor, Mechanical Engineering, Head of Dept., Univ. of Tennessee, Knoxville, Tenn.; Albert E. White, Director, Engrg. Research, University of Michigan, Ann Arbor, Mich.; Alexander R. Stevenson, Jr., Staff Assistant to Vice-President, General Electric Co., Schenectady, N. Y.

Form Aircraft Traffic Conference

Further exemplifying cooperation in the war effort, automotive companies engaged in aircraft production have joined with the aviation companies in forming the Aircraft War Traffic Conference, a joint transportation organization to speed war production. The conference will serve as a clearing house for research, interchange of experience, technique, and information on all phases of aircraft traffic—loading and shipping, rates, classification, bills of lading, and routing. The conference will present the views of the manufacturers to interested regulatory government agencies and freight carriers. It also will cooperate with the Army Air Forces and the Navy Bureau of Aeronautics.

Kenneth A. Moore, manager of the traffic division of the Automotive Council for War Production, has been appointed manager of the conference.

Business in Brief

Written by the Guaranty Trust Co., New York, Exclusively for AUTOMOTIVE AND AVIATION INDUSTRIES

Moderate fluctuations of general business activity continue. The seasonally adjusted index of *The New York Times* for the week ended June 13 was 131.4 per cent of the estimated normal, as against 131.0 for the preceding week and 130.0 a year ago. The unadjusted index of *The Journal of Commerce* for the same period rose to 122.7 per cent of the 1927-29 average from 122.2 for the week before.

Department store sales during the second week of June, as reported by the Federal Reserve Board, were 3 per cent below the level a year ago, in contrast with an excess of 7 per cent over the comparable 1941 figure shown a week earlier. For the four weeks ended June 13, the total was 2 per cent less than corresponding sales last year.

Railway freight loadings in the week ended June 13 totaled 832,726 cars, 2.6 per cent fewer than the number for the preceding week and 3.5 per cent below the figure a year ago.

Electric power output rose more than seasonally in the same period and was 11.7 per cent above that a year ago, as against a corresponding excess of 9.6 per cent shown a week earlier.

Crude oil production during the week ended June 13 averaged 3,700,350 barrels daily, 99,350 barrels above the figure for the preceding week and 64,050 barrels more than the average output recommended by the Office of the Petroleum Coördinator.

Average daily production of bituminous coal in the same period was 1,858,000 tons, as compared with 1,871,000 tons for the week before and 1,675,000 tons a year ago.

Engineering construction contracts awarded during the week ended June 18, totaling $155,670,000, according to *Engineering News-Record*, dropped 59 per cent below the figure for the preceding week and 10 per cent below that a year ago. The 1942 total to date, however, stands 76 per cent above the corresponding sum last year.

Professor Fisher's index of wholesale commodity prices for the week ended June 19 stands at 106.5 per cent of the 1926 average, one fractional point below the level a week earlier, as against 94.3 a year ago.

Member bank reserves rose $77 million during the week ended June 17, and estimated excess reserves increased $10 million to a total of $2,790 million. Business loans of reporting members rose $10 million in the preceding week and stood $788 million above the total a year ago.

CALENDAR

Conventions and Meetings

National Petroleum Association, Atlantic City, Annual Mtg. .....Sept. 16-18

Natl. Safety Council, Chicago, Annual Mtg. .....Oct. 5-9

Natl. Metal Congress & Exposition, Cleveland .....Oct. 12-16

American Welding Society, Detroit, Annual Mtg. .....Oct. 12

Natl. Lubricating Grease Inst., New Orleans, Annual Mtg. .....Oct. 25-29

One-Lung Tester

The Wright Aeronautical Corp., seeking a less expensive method of testing new engine features, has hit upon the idea of mounting only one cylinder on the crankcase of a Cyclone 9-cylinder engine. Thus, reports show, new cylinder, valve, and spark plug designs may be tested just as effectively at a fraction of the cost attending full-scale experimentation in a regulation test cell.

Acme

Scrap Collection Under Strict Control

WPB Lists Eighteen Classifications of Scrap Steel, Outlines Methods of Using Salvage in Making New NE Steels

By W. C. Hirsch

Shop methods of automotive and airplane parts plants have been brought under more direct War Production Board control by issuance of a mandatory order for the segregation of all alloy-steel scrap. The Division of Industry Operations has set up 18 classifications, the first nine of which are constructional steels, containing combinations of nickel, chromium, and molybdenum. Three classes, aimed at the conservation of molybdenum, chromium, and vanadium contained in high-speed tool steels follow. Five categories take care of the chromium and nickel contained in heat and corrosion resistant alloys with those which, besides chromium and nickel, may contain molybdenum, cobalt or copper, making up the eighteenth class.

"When alloy scrap is thrown into a melting furnace without regard to its content, the alloy is, in effect lost," says the WPB release outlining the new mandatory regulations. Continuing, it says, "The steel produced from such scrap may have a content of alloys not called for. If it is segregated, however, and used to make *National Emergency Steels*, all of the scrap can be taken into account in producing the new steel.

"If the scrap contains 0.5 per cent nickel and 0.1 per cent molybdenum, the production of *NE* steels with 0.6 per cent nickel, 0.5 per cent chromium and 0.2 per cent molybdenum will require chromium additions, but reduced amounts of new nickel and molybdenum, in proportion to the quantities of those elements in the scrap and the amount of scrap charged. High percentages of nickel, tungsten, and molybdenum in scrap are recoverable. Chromium is recoverable in electric furnaces and to a limited extent in open-hearths, depending upon the melting practices employed. Thus segregation of scrap will permit its flow into channels where it will do the most good, particularly in the production of *NE* steel."

Regarding methods available for segregating alloy scrap, the WPB release says that the most common consists of the use of colored containers or bins, with each color corresponding to an alloy specification. In the opinion of salvage engineers, who ever since World War No. 1, in which, by the way, virtually no attempt was made to segregate one kind of alloy steel scrap from another, have studied this problem, the War Production Board's mandatory order covering alloy steel scrap should go far in making the supervisory personnel of even small plants conscious of the importance of properly handling borings, turnings, clippings, and other forms of scrap.

That the War Production Board is giving more and more of its attention to the conservation of alloy elements is shown by issuance of another order

(*Please turn to page* 62)

Press Association

U. S. Base In Guatemala

A U. S.-built four-wheel-drive truck bearing an anti-aircraft gun crew rumbles across the parade ground as Guatemalan and U. S. troops stage a joint review at a U. S. outpost in the Central American republic. Note the Flying Fortress in the background. The plane appears to be a 17-E the latest Boeing design.

Limit Distribution Of Precision Tools

Distribution of gages, precision measuring tools, testing instruments, and chucks has been brought under stricter control by the issuance of General Preference Order E-5.

Under the order no gage, precision measuring tool, or testing instrument, may be sold except pursuant to a rating of A-10 or higher. Produce present delivery schedules for these products, however, may be maintained for thirty days from June 15 without change. Thereafter purchase orders will be scheduled according to the terms of the order.

Heads Ford News Bureau

Steve Hannagan, public relations counsel who handled the Indianapolis Speedway account for many years, and also made Miami famous, has been appointed press relations representative of the Ford Motor Co., according to announcement of president Edsel Ford. He will establish a news bureau in the Ford Administration Building in Dearborn, in charge of Joe Kopps.

New Rationing Director

Dr. Charles F. Phillips of Syracuse, N. Y., has been appointed to the newly created position of Director of the Automotive Supply Rationing Division of OPA. He will supervise tire, passenger automobile, and bicycle rationing.

Hubert G. Larson, who has been named Chief of the Automobile Rationing Branch, succeeds Rolf Nugent, former chief, who now directs OPA's Consumer Requirements Division.

Launch Plane Plant Expansion

Curtiss-Wright Corp. has launched a $10-million expansion program to increase its manufacturing and office facilities. This will enable the company to step up production of C-46 Army twin engine cargo planes and P-40 fighter planes. Wood and concrete will be substituted to save steel in the new expansion.

ODT Plans Check On Transport Needs

In order to bring about greater utilization of existing freight transportation facilities, the Office of Defense Transportation has initiated a plan designed to provide an accurate monthly forecast of the Nation's freight equipment requirements.

ODT Director Eastman has asked a large representative group of manufacturers, producers, and distributors to submit, beginning June 15, an advance monthly estimate of traffic movement from their establishments. The information, to be provided on a special form, will include the commodity to be shipped.

Discontinue Division

The Morrison Machine Products Division of Hardinge Bros., Inc., Elmira, N. Y., has been discontinued. Their products, consisting of collets, feed fingers, pads, form tools, and cut-off tools for automatics, turret lathes, and chucking machines becomes a part of the Hardinge line and will be sold under the name of Hardinge.

PUBLICATIONS

The Bristol Co. has just published a new Bulletin No. T302, on its line of **Fully-Compensated Liquid-Filled Recording Thermometers.** The bulletin gives detailed information concerning construction of the instrument, the various forms in which it is furnished, and information concerning its application.*

Walter Kidde & Co. has just released the first issue of its new house organ **High Pressure,** which contains an article on extinguishing methods for oil type incendiary bombs.*

The B. F. Goodrich Co. has just issued the 7th in the series of vest-pocket size pamphlets telling how to care for and conserve **industrial rubber products.** The new pamphlet describes how to get the most service from electricians, acid and other industrial type rubber gloves.*

A Cooperative Plan of Truck Conservation is the title of a booklet by The White Motor Co., dealing with preventive maintenance and parts conservation.*

A new catalog on **Industrial Equipment** has just been issued by S. F. Bowser & Co. A copy may be secured by writing to the company at Fort Wayne, Indiana, on your company letterheads.

Air-cooled induction feeder voltage regulators, especially designed for feeder circuits and industrial plants, are described in a new 11-page bulletin announced by Westinghouse Electric and Mfg. Co.*

The A B C of O.D. Grinding—Cylindrical and Centerless is the title of a booklet just issued by the Norton Company.*

A new catalog on **machine tool motorizing** has been issued by Drive-All Mfg Co. A feature of the catalog is the full treatment of a simplified technique of mounting individual motorizing units with standardized brackets on any type of machine tool.*

Section No. 6, **Aircraft Equipment,** the answer to production and servicing problems in the aviation industry, has just been issued by Lyon-Raymond Corp.*

The Lincoln **Shield-Arc,** the welder with self-indicating dual continuous control, is described and illustrated in a new booklet just issued by Lincoln Electric Co.*

Duro Mfg. Co.'s new booklet on machine tools for high-speed production describes, illustrates, and gives specifications for its **punch presses** and **bench millers.***

The Division of Information, Office for Emergency Management, has issued an **OEM Handbook** which describes the organization and function of the various war agencies, lists the personnel, and gives organizational charts for the more important subdivisions. Copies may be obtained through OEM field offices; from the

(*Please turn to page* 66)

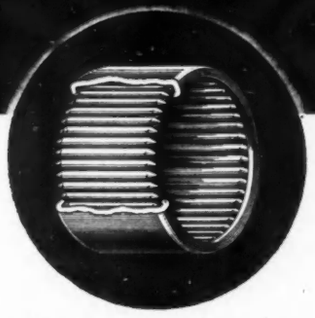
40 YEARS AGO

THE COUNTER SKID

A device bearing the above name has recently been placed upon the English market, which is said to render side slipping absolutely impossible. It is an attachment to the back axle of the car, consisting of two hinged brackets, working on the positive and negative principles. At the bottom of each bracket there is a loose steel wheel with cutting edge, which engages, instantly and automatically, with the road surface as soon as there is any tendency toward side slipping. Severe tests conducted on greasy wood and asphalt pavements in London are said to have proved the new invention to be perfectly reliable. The device is marketed by F. Sadler, 13 Deering street, Oxford street, W., London.

From *The Horseless Age*, July 2, 1902.

ONE SPECIFICATION THAT *HASN'T* CHANGED



HE used to design knitting machines; now he's working out the details of aircraft sub-assemblies. Or perhaps he has "changed over" from blueprints of streamlined trains to medium tanks—and so it goes.

He was able to take conversion in stride because of his background, resourcefulness and adaptability to new problems and requirements. You'll find fresh evidence of this every day on assembly lines all over America.

The Torrington Needle Bearing, too, has "changed over"—and its adaptability is proving itself anew—in applications where its unique advantages mean more today than ever.

Its small size, for example, is saving space and critical materials. Its remarkable ease of installation is cutting assembly time . . . its low coefficient of friction, assuring smooth performance . . . its high capacity and efficient lubrication, reducing the need for replacement or maintenance attention—all are vital wartime features.

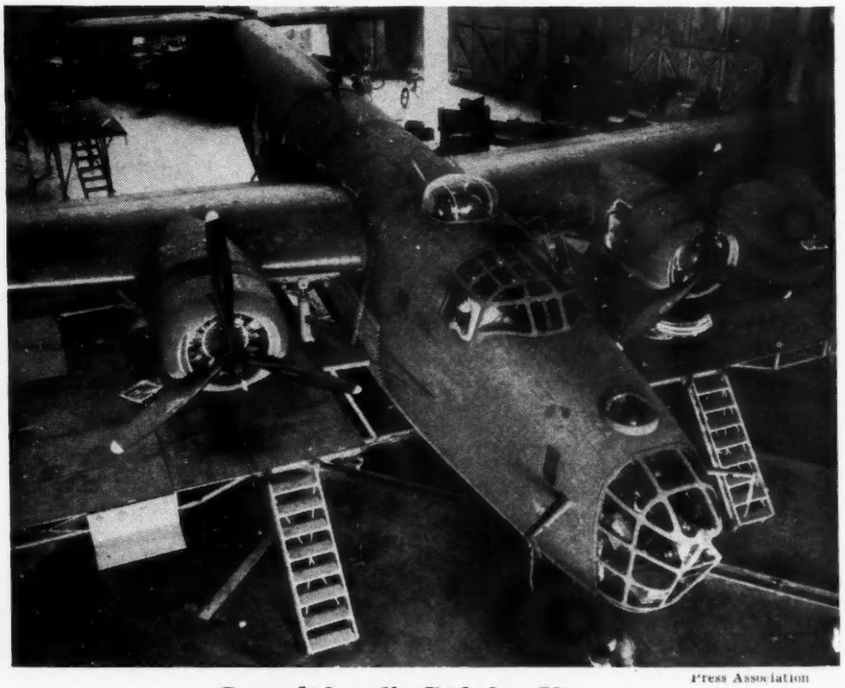
It is not surprising, then, that engineers and designers, in changing over to war production, have found the Needle Bearing to be one of the important specifications they haven't had to change.

FOR INFORMATION *concerning capacities and sizes, send for Catalog No. 107 Or consult a Torrington engineer. He is an expert in adapting the Needle Bearing's advantages to specific problems.*

THE TORRINGTON COMPANY
TORRINGTON, CONN., U. S. A. • *Est.* 1866
Makers of Needle and Ball Bearings
New York Boston Philadelphia Detroit
Cleveland Seattle Chicago Los Angeles
San Francisco Toronto London, England

TORRINGTON NEEDLE BEARING

Every feature fills a wartime need



Press Association

Consolidated's Bid for Victory

The Consolidated B-24, called the Liberator by the British, has proved its worth in many operational flights in the past few months. In the hands of American airmen, this type of plane was used in the recent attack on the Italian fleet in the Mediterranean. A four-engine bomber, the B-24 is looked upon as one of the mainstays of American aerial might. Although total defensive fire power remains a military secret, the plane is said to be well armed against fighter attack. The top-side turret, shown above, was not installed in earlier models.

MEN . . . . . .

Alfred Sontag has joined the staff of the testing machine department of The Baldwin Southwark Division of The Baldwin Locomotive Works. He was formerly chief engineer and sales manager of Riehle Testing Machine Division of American Machine and Metals.

Roger Mather, formerly of the Inland Steel Co., has been appointed to the engineering staff of Willys-Overland Motors.

L. H. "Larry" Chenoweth, manager, Manufacturers' Sales, in the Industrial Products Sales Division of The B. F. Goodrich Co., has been granted a leave of absence to serve on the Rubber Products Division of WPB. **I. N. Kimsey,** Akron district manager, is handling Mr. Chenoweth's duties in Washington. **Robert T. Kain,** sales engineer in the belting department of the same division, has been commissioned lieutenant junior grade in the U. S. Navy.

Edsel B. Ford, president of Ford Motor Co., has been elected president of the Horace H. Rackham Engineering Foundation, Detroit, succeeding the late Alex Dow. Lieut. Gen. William S. Knudsen is a member of the board of trustees.

Earle D. Bottom, formerly assistant sales manager of the Ford Motor Co., has been commissioned a lieutenant-colonel in the Quartermaster Corps Motor Transport Division of the U. S. Army.

John Morrow, Jr., vice president in charge of purchasing for International Harvester Co., has left the company to take up duties as a colonel in the Services of Supply of the U. S. Army.

Charles L. Nielson, secretary of Fleetwings, Inc., has been given the additional duties of controller. **Rudolph Funk,** formerly a project engineer, has been appointed superintendent of the manufacturing plant under lease from the Defense Plant Corp.

Ormond E. Hunt, vice president and director of engineering of General Motors Corp., was awarded the honorary degree of doctor of science in engineering at the annual commencement exercises of Wayne University June 11 at Detroit.

R. E. Gilmor, president of Sperry Gyroscope Co., and **R. Randall Irwin,** industrial relations director of Lockheed Aircraft Corp., have been appointed members of the management-labor policy committee of the War Manpower Commission.

W. J. Mougey, advertising manager of Pontiac Motor Division, has been granted a leave of absence to join the staff of Paul Garrett, General Motors vice president and director of public relations. **B. B. Kimball,** assistant advertising manager, will assume Mougey's duties during his absence.

Col. Richard Z. Crane, chief of the Detroit Ordnance District, largest of 13 such districts in the nation, for the last four years, has been transferred to duties in Washington. He will be succeeded by **Col. A. B. Quinton, Jr.,** who held the Detroit district post for four years prior to 1938.

Albert Kahn, Detroit architect, who has designed many large automotive and defense plants, was awarded the honorary degree of doctor of laws June 9 at the annual commencement exercises of Syracuse University.

Hans Bohuslav, formerly vice president in charge of engineering with the Enterprise Engineering Co., has joined the Sterling Engine Co. as vice president in charge of engineering.

Don U. Bathrick, general sales manager of the Pontiac Motor Division, has been appointed assistant to R. H. Grant, vice president of General Motors in charge of relations between GM and the government in connection with war materials.

John M. Lupton has joined the staff of Acheson Colloids Corp. as advertising manager.

Dr. Harlan L. Trumbull, manager of the chemical research dept. of the B. F. Goodrich Co. since 1922, has been selected to head a research project to study the present sources of rubber in North America.

Carl A. Ostling, plant layout expert, has been appointed director of engineering of the U. S. Rubber Co.

Royce G. Martin, president of Electric Auto-Lite Co., has been appointed chairman of the automotive parts division of the War Production Fund to Conserve Manpower.

ADVERTISING

Brooke, Smith, French & Dorrance, Inc., Detroit, has been appointed to handle the advertising account of the Howell Electric Motors Co.

Young & Rubicam, Inc., has been appointed advertising agency for the Consolidated Aircraft Corp.

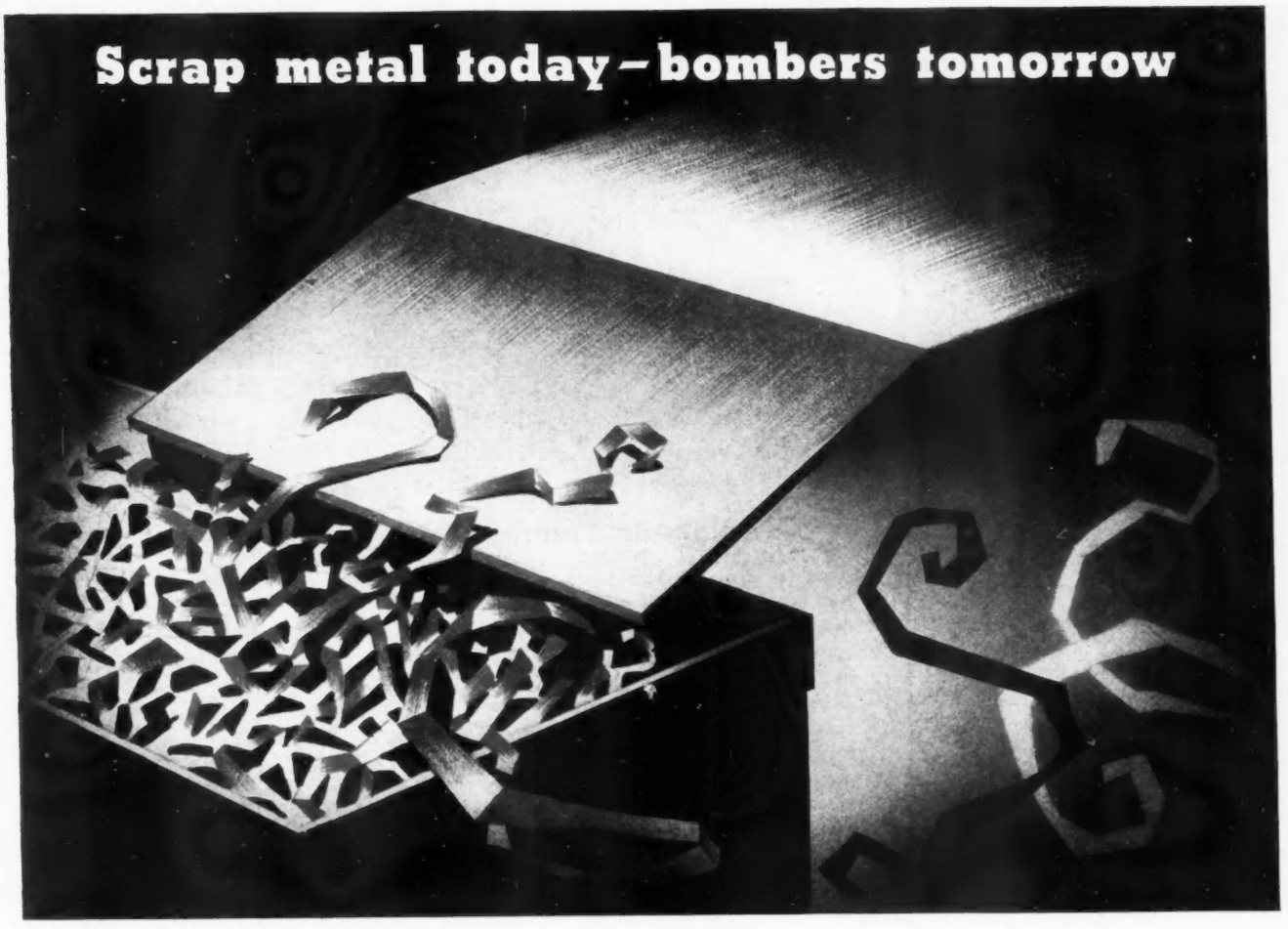
J. Walter Thompson Co. has been appointed to handle advertising for The Garrett Corp.'s divisions, AiResearch Mfg. Co., Garrett Supply Co., Airsupply Co., and The Northill Co., Inc.

Acme

Wrapping Up the Jeeps

Engineers at the Willys-Overland plant have managed to use every available nook in these crates which carry one Jeep apiece. Windshields and wheels are removed and placed within the truck, thus affording more efficient packaging.

Scrap metal today—bombers tomorrow



Information supplied by "Automotive and Aviation Industries"

Conservation at a western airplane plant has been put on a scientific basis with scrap collection and segregation in charge of a metallurgist. Under his direction one man on each shift in each department is assigned to scrap collection, a separate box being provided for each type of "trash". The full boxes are hauled to the salvage yard by lift truck where the scrap is re-checked for proper segregation.

The scrap thus reclaimed amounts to over $1,000,000 annually in this plant alone. WPB officials calculate that on a National basis aircraft plant aluminum scrap alone would amount to enough aluminum for 250 Flying Fortresses, while enough magnesium scrap could be segregated for 50,000 incendiary bombs.

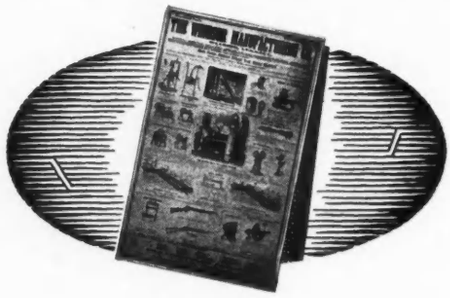
Where scrap collection and segregation was once a junk business it is now an operation of major importance in well-run plants — and may well produce the vital materials necessary for fulfillment of production schedules.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company
500 Fifth Avenue • New York City

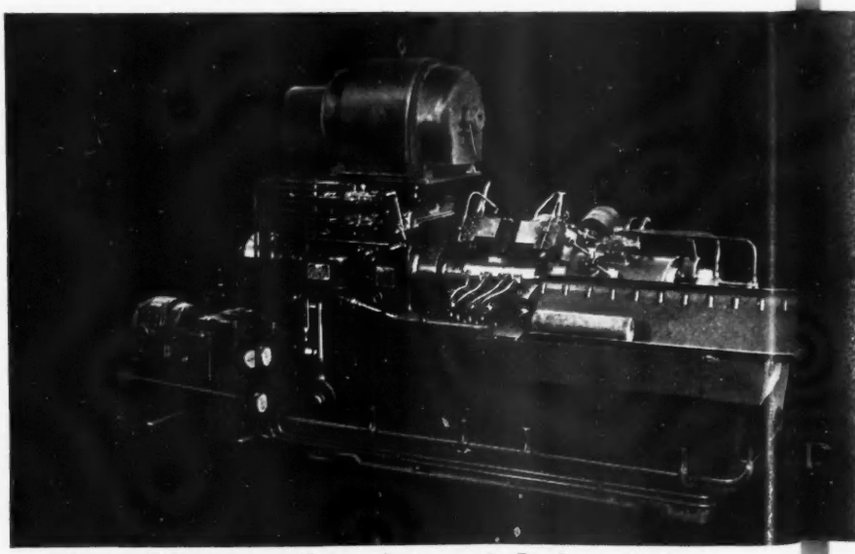
MOLY

"PLEASE POST THIS IN



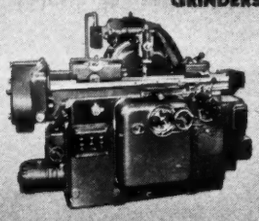
"The Lamson Catalog of 1865"

NEITHER Jones & Lamson nor its early predecessors has ever been backward about keeping industry informed of the newest developments in their machine tool line. When American missionaries were first bringing the Bible to heathen lands, Vermont machine tool men afoot, on horseback, flatboat and stagecoach were tooling infant industries on the frontiers of America. Sometimes these hardy salesmen ran out of cash on the road. One of them labored for weeks as a bartender in a hotel to earn money to travel on. Today Jones & Lamson representatives travel by auto, rail and air, but they are no less eager than their predecessors to bring you information of new ways to speed production.

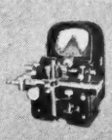


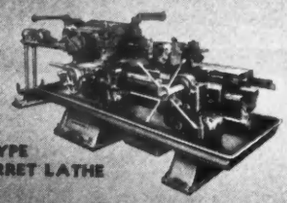
Jones & Lamson 16″ Fay Automatic Lathe tooled to machine a shell.

AUTOMATIC THREAD GRINDERS



OPTICAL COMPARATORS





RAM TYPE UNIVERSAL TURRET LATHE

A CONSPICUOUS PLACE"

THE machines shown in this catalog are no longer made. But there is one item worth remembering that can help you meet today's emergency and safeguard future earnings in postwar competition.

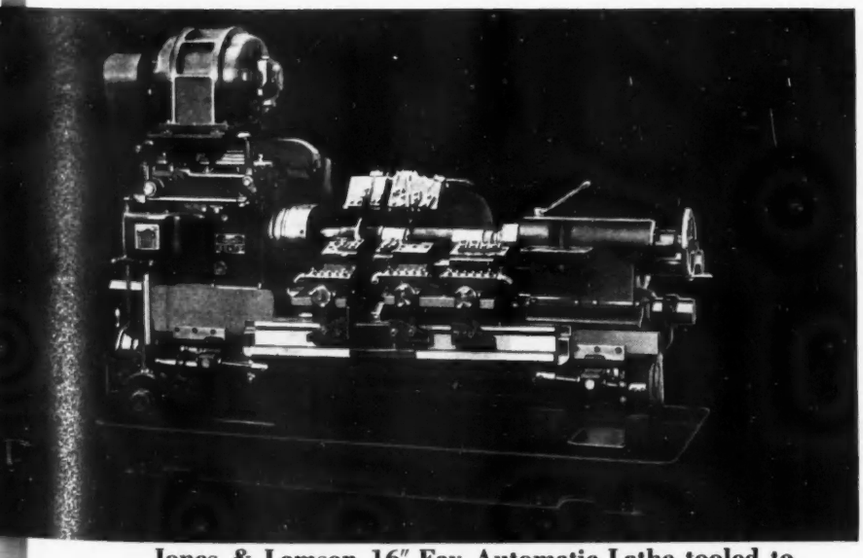
Now, as in 1865, Jones & Lamson equipment offers advances in machine design and precision workmanship that enable you to take every possible advantage of available cutting tools.

Specifically, Jones & Lamson Turret Lathes, Fay Automatic Lathes and Automatic Thread Grinding Machines embody numerous refinements that make for rapid, effortless low-cost operation. Into them are built excess reserves of speed, rigidity and *useful* power that permit maximum employment of any hard alloy tool or high speed grinding wheel now made, or likely to be made in the near future.

Detailed information of these features is available in the newest illustrated Jones & Lamson catalogs. Inquiries from large plants or small receive careful study here. It pays to put production problems up to Jones & Lamson engineers.

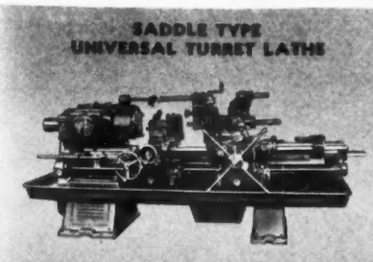
JONES & LAMSON

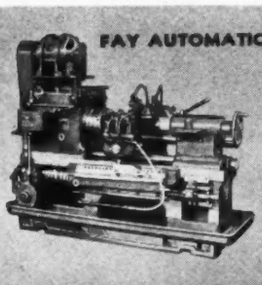
MACHINE COMPANY · Springfield, Vermont, U.S.A.



Jones & Lamson 16″ Fay Automatic Lathe tooled to machine a rear axle housing.

Manufacturers of Ram & Saddle Type Universal Turret Lathes . . . Fay Automatic Lathes . . . Automatic Thread Grinding Machines . . . Comparators . . . Automatic Opening Threading Dies and Chasers





PROFIT PRODUCING
MACHINE TOOLS

Industry's Conversion

(*Continued from page* 45)

higher rate of war production are men and materials. Production of welded metals is being increased through construction of new processing facilities, development of low grade ores, intensive scrap salvage drives and tapping of new sources of supply. The manpower shortage is not yet serious except in certain highly skilled occupations, such as toolmakers and tool designers.

Reports on their war products now are being received by the automotive companies from the far-flung battlefronts of the United Nations. Jeeps, the maneuverable ¼-ton reconnaissance cars made by Ford and Willys, are in evidence on many continents. They are seeing service in Australia, Iceland, Ireland, China, Burma, and India—in fact, wherever U. S. troops are stationed. Ford-built Pratt & Whitney 2000-hp. engines powered some of the Army bombers that participated in the Battle of Midway Island, with disastrous results for the Japanese fleet. Packard-built Rolls-Royce Merlin engines are being shipped to England to power the Lancaster bombers that played a big part in the destructive raids on Cologne and Essen. Merlins also are installed in the famed Hurricane and Spitfire fighters as well as the U. S. Warhawk, latest version of the Curtiss P-40. Packard marine engines also have performed to good account in the Philippines, powering the swift patrol torpedo boats of the U. S. Navy. Reports on shells, guns, and other equipment made in automobile plants are less specific except that the armed forces want more of them.

Stepped-up production by automotive companies like Ford, Buick, Packard, Chevrolet, and Studebaker has helped boost aircraft engine production 80 per cent since Pearl Harbor. Since September, 1939, the U. S. aircraft industry, now being augmented by the automotive plants, has produced $4 billion worth of planes, engines, and propellers, according to John H. Jouett, president of the Aeronautical Chamber of Commerce.

Helping achieve this increased production has been a growth in the practice of subcontracting. From only 13 per cent in March, 1941, subcontracting in airplane manufacturing jumped to 24 per cent in October, 1941, and 36 per cent in March, 1942. Entry of the Government-financed bomber assembly plants into production has boosted the percentage in recent months, according to T. P. Wright, assistant chief of the Aircraft Section of WPB.

Latest aircraft engine manufacturer to reach volume production is Packard, which is turning out Rolls-Royce Merlin engines for Great Britain and the U. S. in quantity lots. Allison is the only other U. S. manufacturer in production on liquid-cooled airplane engines, having worked on the development of such an engine for nine years. Packard received its Rolls-Royce order in July, 1940. Since Pearl Harbor, orders for the Rolls-Royce engines have been boosted 75 per cent. With its aircraft and marine engine building, Packard is devoting 81 per cent of its plant space to war work, with the other 19 per cent on automobile replacement parts production and storage of automotive machinery.

The Merlin engine contains nearly 11,000 parts compared to 7140 parts in a 1942 Packard sedan, including both engine and body. It takes 77 times as many standard hours to assemble a Rolls-Royce Merlin as it does a Packard eight-cylinder automobile engine. The major parts of the aircraft engine require between 75,000 and 80,000 machine operations. It takes 70 times as many man-hours to machine a Rolls connecting rod as it does to machine an automobile connecting rod. An aircraft cylinder block requires eight times as many man-hours as an automobile block. The Rolls crankshaft requires 20 times as many man-hours of labor as the automotive crankshaft, and the aircraft crankshaft alone costs more

(*Please turn to page* 60)

Stuart's Cutting Oil Service will help you get the most out of *Minutes, Metals* and *Machines*

Stuart's Thred Kut
HEAVY DUTY CUTTING OIL
Recommended by America's leading machine tool builders

Stuart's SOLVOL
LIQUID CUTTING COMPOUND
For carbide tools and where an "aquamix" solution is recommended

Stuart's CODOL
LIQUID GRINDING COMPOUND
Meets every test for the ideal Modern Grinding Compound

Stuart's "SUPER-KOOL"
AMERICA'S FIRST TRANSPARENT SULPHURIZED CUTTING AND DRAWING OIL

OUR job is to keep cutting oil research and engineering service abreast of the progress made in machines, tools, metals and processes; to make sure the metal working industry has every advantage that modern cutting oils can make possible.

We've done that job since 1865 — done it well, industry has acknowledged.

Example after example can be cited where management and technicians of vital war products plants, government and private, have worked with Stuart Oil Engineers to solve new and difficult problems that were barriers to peak production. The key to every such solution has been found in an open-minded approach—close cooperation—in using unbiased judgement — and a determination to achieve results.

This is why we feel that you will find Stuart Oil Engineering Service helpful in solving metal cutting problems. It has been our job since 1865.

For All Cutting Fluid Problems
D. A. STUART OIL CO.
Chicago, U.S.A. • LIMITED • Est. 1865
Warehouses in All Principal Metal Working Centers

a letter to Bryant

We may *think* we have only one problem. That problem of course is war production. To help solve it, Bryant productive capacity, already tripled, is constantly increasing.

But right now, today, we already have another problem, and that problem is to find new markets for American products, the moment peace returns.

If we are going to solve this problem we must find new ways to make more and better things that more and more people will be glad to buy for less and less money.

If we are going to solve this problem in time, we better start solving it now.

Probably you have already started. If your plans include jobs with internal grinding, it should pay to put the facts in a letter to Bryant. Just as Bryant engineers have found so many ways to combine operations, cut costs and speed defense production, so can they be expected to point the way to new profits on your future business.

And all the greater should be Bryant's opportunity to render substantial assistance if allowed to work with you at the earliest possible stages. By all means sit down today and put the facts in a letter to Bryant.

BRYANT CHUCKING GRINDER CO.

SPRINGFIELD, VERMONT, U. S. A.

(*Continued from page* 54)

than an entire automobile engine. There are 72 gears in the aircraft engine compared to five or six in an automobile engine.

The Rolls-Royce engine requires 194 hr. for original assembly plus an additional 228 hr. for teardown and reassembly. A Packard automotive engine takes 5 hr. for assembly. Packard now has more than 20 test cells in operation but this will be doubled to meet the expanded production program. The 6-hr. "green" run is followed by a 10-hr. run after teardown and reassembly. It takes 23,000 gal. of gasoline and 3000 gal. of oil to operate the test cells every 24 hr.

Another manufacturer that started early in the war program was AC Spark Plug Division of General Motors, which with three other GM plants shared a large order for machine guns. Production began in April, 1941. By May, 1942, 14 months later, output was 93 per cent greater than the original schedule for that month. May production also was 16 per cent above production for the previous month. Expanded facilities and inaugural of the swing shift have helped AC to boost its output.

BUY

DEFENSE BONDS AND STAMPS

. . . AND LONGER LASTING AETNA BALL BEARINGS

☆ Remember the wiser you buy the more you help to conserve labor and materials that are indispensable to a nation at war—to *VICTORY!*

Long-lived, dependable AETNA PRODUCTS mean less frequent replacements, increased production and extended machine life. You save for yourself, for your country.

AETNA BALL BEARING MFG. CO.

4600 Schubert Ave., Chicago

Thrust Ball Bearings (Standard and Special) . . . Angular Contact Ball Bearings . . . Roller Bearings (Special) . . . Ball Retainers . . . Hardened and Ground Washers

Graham-Paige to Build Amphibian Tanks

Production of large amphibian tanks for the U. S. Navy is underway at the Graham-Paige Motors Corp., Dearborn, Mich. The tanks have steel treads and will be used to transport men and materials. Tests in marshy ground on the shore of Lake Huron have revealed the ability of the amphibian vehicles to negotiate swamp-land or rocky terrain. Details of the size, power, and performance of the armored vehicles have been withheld by the Navy.

"Overshoe" Preserves Worn-Out Carcasses

Although no acceptable solution to the severe civilian tire shortage is near at hand, recent developments show that at least one makeshift will soon be made available.

According to a major tire maker, it will shortly announce an "overshoe" for tire casings. Made chiefly of cotton, the "overshoe" is understood to contain no strategic materials; wrapped around the merest carcass, it is said to provide for another 2500 to 10,000 miles of service. But high-speed driving is out for two reasons: the substitute materials cannot withstand the greater forces and higher temperatures, and no non-skid tread is provided.

Ford to Build Gliders

Ford Motor Co. has been asked by the government to produce large gliders capable of transporting troops or equipment. These gliders, manufactured of wood and plywood, will be made in one of Ford's Michigan plants formerly devoted to wood-working activity on station wagon bodies and similar products.

Controls Rubber Imports

The War Production Board, on the recommendation of the Board of Economic Warfare, has prohibited the importation of rubber and rubber products, including balata, except by subsidiaries of the Reconstruction Finance Corporation.

The Rubber Reserve Company of RFC, which has heretofore been the sole importer of crude rubber and latex, will now also undertake the purchasing of reclaimed and scrap rubber in any form, as well as finished rubber products and balata.

New Sales Office

The Gisholt Machine Co., Madison, Wis., has announced the establishment of a branch office in Pittsburgh at 1124 Park Building.

"PUT IT ON THE BLANCHARD"

BLANCHARD

FLAT WITHIN .000007"

CHECK THESE ADVANTAGES OF BLANCHARD GRINDING

- ★ Production
- ★ Adaptability
- Fixture Saving
- Operation Saving
- Material Saving
- ★ Fine Finish
- ★ Flatness
- ★ Close Limits

★

. . . . . *Especially valuable on jobs like the one illustrated.*

Here are semi-cast steel compressor heads being ground on a No. 11 Blanchard Surface Grinder to the almost *unbelievable flatness of* .000007"—(that's seven millionths of an inch). The finish measures 6 micro inches. Yet this is a regular production job in a leading electrical products manufacturing plant. The heads are 7" in diameter and 3¾" thick. .005" of stock is ground off one surface. Production averages 40 parts per hour.

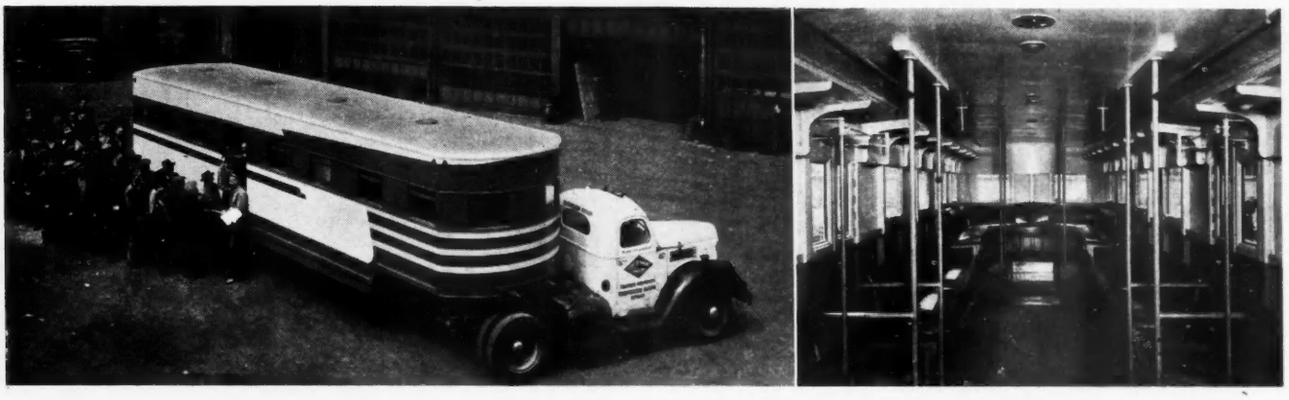
Fast, accurate and easy to operate, this smallest Blanchard Grinder has proved to be profitable for either tool work or small lot production.

Send for your copy of the No. 11 catalog today.

Grinding compressor heads on the No. 11 Blanchard Grinder

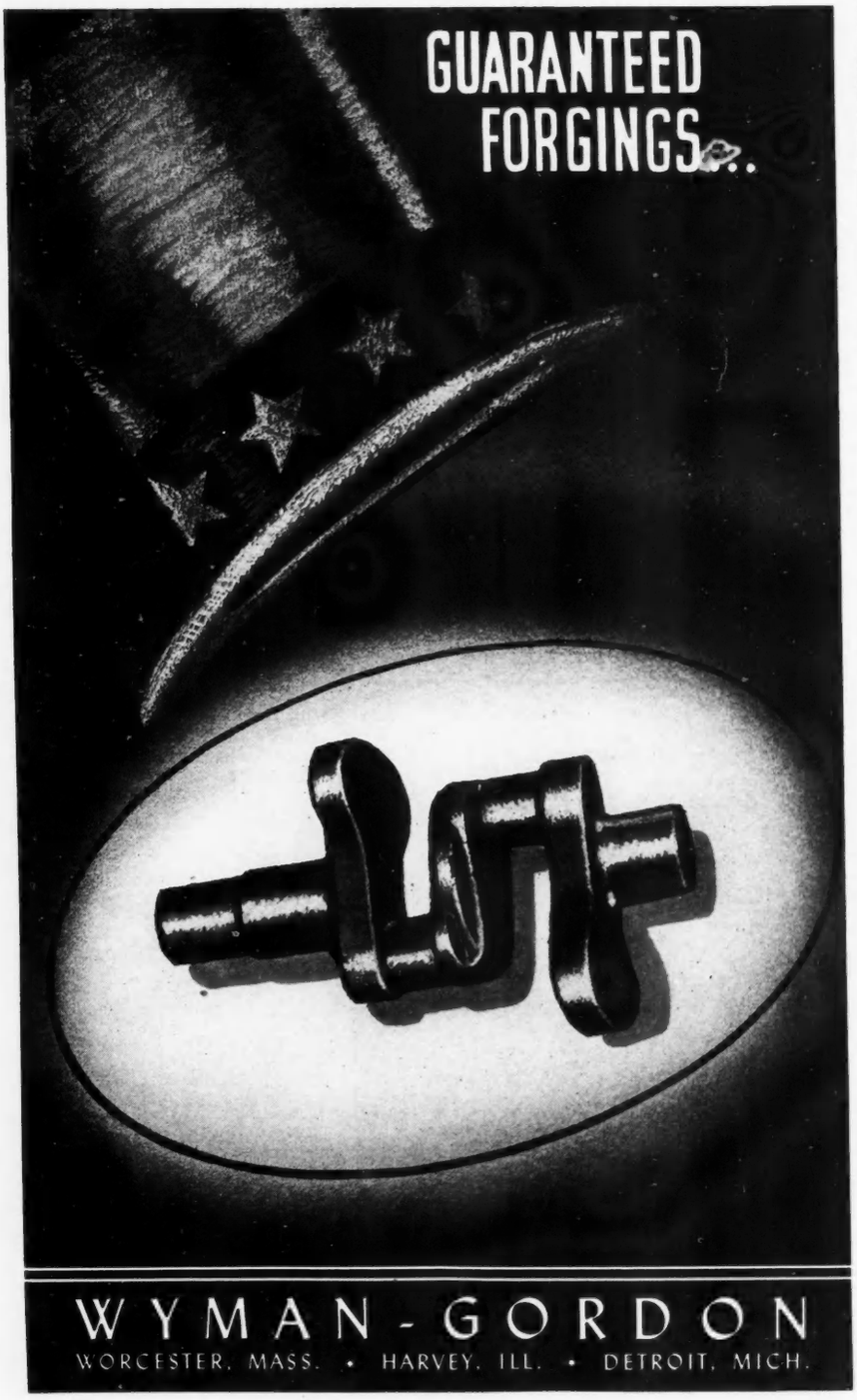
Send for your free copy of "Work Done on the Blanchard." This book shows over 100 actual jobs where the Blanchard Principle is earning profits for Blanchard owners.

The BLANCHARD MACHINE COMPANY
64 STATE STREET, CAMBRIDGE, MASS.



Worker Transport

Built by the Fruehauf Trailer Co. at the request of the Office of Defense Transportation "to meet the problem of transporting a maximum number of workers with the minimum of critical materials," this 100-passenger trailer bus weighs only 11,370 lb. Equipped with differential dual wheels, the trailer is said to effect an appreciable saving of rubber.



Northrop Aircraft Develops Welding Process

After several years of research effort, Northrop Aircraft Inc. has developed a welding process for magnesium. Known as the "heliarc" process, the new method is purported to make possible the arc welding of magnesium sheets, extrusions, and tubings. According to company officials, full details will be made available to the industry in the near future.

Scrap Collection

(*Continued from page* 47)

specifying the maximum amount of chromium and nickel that may be used in the manufacture of automotive exhaust valves, for which a two-piece welded head type of construction, with the use of chromium and nickel permissible in the valve head only, has become obligatory. This, the War Production Board estimates, will save more than 40 per cent of chromium and nickel compared with former manufacturing methods. Contracts placed within 90 days after July 1 by the Army, Navy, or Maritime Commission are exempt from these restrictions.

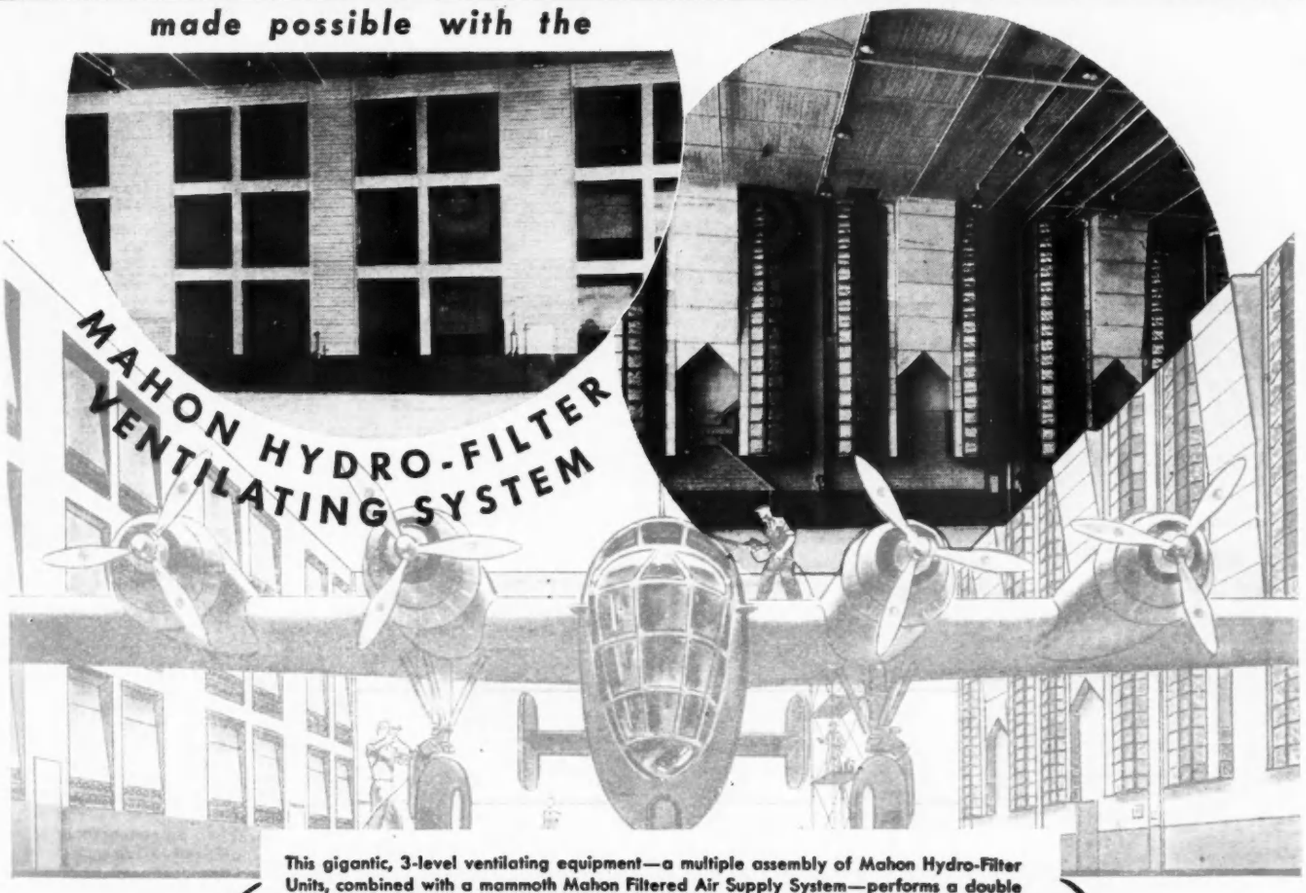
The distribution of tin has now come to be a purely Government affair. Importers and dealers, who formerly were the source of supply for automotive consumers, have been told that there was no room for their services in the distribution program made necessary by the war.

John W. Braffett

John W. Braffett, 49, retired general manager of sales, Oliver Iron and Steel Corp., Pittsburgh, died at his home in Detroit.

A Spectacular Advancement IN AIRCRAFT PAINTING

made possible with the



This gigantic, 3-level ventilating equipment—a multiple assembly of Mahon Hydro-Filter Units, combined with a mammoth Mahon Filtered Air Supply System—performs a double function. It clears the room, at three separate levels, of dangerous overspray and fumes and continuously floods the entire space with washed and filtered air, maintaining an equalized air flow throughout the room. Enclosure is 150′ wide, 100′ long, 35′ high, the largest spray booth and ventilating system ever designed and installed, so far as is known.

SPRAY PAINTED *after* COMPLETE ASSEMBLY

One of the problems encountered by the aircraft industry in meeting the seemingly impossible demands of modern war production was the painting—*after complete assembly*—of an entire airplane. Such an undertaking necessitated not only a spray painting enclosure of immense proportions but a satisfactory means of exhausting the paint-laden air from the enclosure and replacing it with washed and filtered air to insure operator protection and adequate safety precautions against fire and explosion. The problem was put up to Mahon engineers for solution. They succeeded in solving it by designing the ventilating system, described and pictured above. It offers compelling evidence of the ability of the Mahon organization to participate in the working out of ANY spray painting project—big or little—in the aircraft industry—or elsewhere.

For the interesting details of this achievement, write

THE R. C. MAHON COMPANY • DETROIT • CHICAGO

Metal Cleaning Machines, Rust Proofing Machines, Hydro-Filter Spray Booths, Ovens of All Types, Filtered Air Supply Units, Hydro-Foam Dust Collectors—and many Other Units of Special Production Equipment—including Complete Finishing Systems.

MAHON

Exceeds Schedule In Gun Production

The Fisher Body Division of GM is in production on large caliber anti-aircraft guns five months ahead of schedule, E. F. Fisher, general manager, has announced. Less than four months after work began on the project, guns are being turned out. The gun is known to have a range in excess of 30,000 ft. and can reach a bomber flying 7 miles high. It is a mobile weapon, shoots an explosive shell, and can be fired by remote control.

When maximum production is reached, the guns will be built on a progressive assembly system, probably the first time so large a weapon has been manufactured on such a basis. The project has been divided among several Fisher Body plants and each one assigned a special phase of the work. Tolerances are extremely close, as a variance of 1/1,000 of an inch in a certain part would result in the projectile missing its mark by more than 60 ft. Each gun requires 25,000 lineal inches of welding of a specialized type for which Fisher Body automotive welders had to be retrained.

Fisher Body also has been awarded a construction-management contract by the War Department for a new plant in Ohio.

How TO GET THE MOST FROM YOUR KENNAMETAL* TOOLS

KENNAMETAL IS OF VITAL IMPORTANCE TO THE WAR EFFORT

Because it machines steels hardened as high as 550 Brinell at speeds 2 to 6 times faster than are possible with high speed steel, KENNAMETAL is helping hundreds of armament manufacturers meet production schedules. Proper use of KENNAMETAL lengthens tool life and at the same time increases production speed:

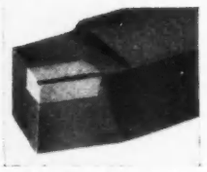
CHECK YOUR MACHINE: Be sure the motor is strong enough to pull the cut at the speed required. If not, reduce the feed until the machine will pull the cut without stalling, but don't reduce the R.P.M. to give a speed below that recommended. (See Vest Pocket Manual on KENNAMETAL cutting speeds.)

ELIMINATE CHATTER: Machine should be stopped immediately when chatter develops. Re-grind tool with smaller nose radius to eliminate chatter. Different combinations of feeds and speeds should be tried. When possible, older machines should be run on open belt.

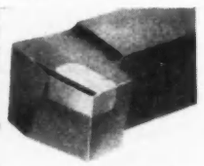
APPLY COOLANT CONTINUOUSLY: When coolant is used, a continuous flow should be directed at cutting point at all times.

CHANGE TOOLS REGULARLY: KENNAMETAL tools should be changed before they get too dull. Over-dull tools require too much grinding, reduce tool life considerably.

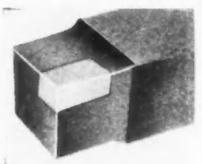
RUN AT PROPER SPEED: KENNAMETAL tools operate more efficiently at speeds at least double those of high speed steel tools on similar work. Don't run too slow. Use your KENNAMETAL tools correctly and you'll get more work from them, increasing production speed and lowering costs. Write for the KENNAMETAL Vest Pocket Manual, containing complete, easy-to-follow instructions.



STYLE 11 TOOL



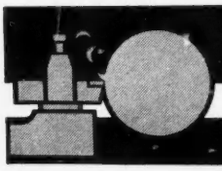
STYLE 21 TOOL



STYLE 3 TOOL

KENNAMETAL THE All American CARBIDE

*INVENTED AND MANUFACTURED IN U. S. A.



McKENNA METALS Co.

105 LLOYD AVE., LATROBE, PA.

Foreign Sales: U. S. STEEL EXPORT CO., 30 Church St., New York
(Exclusive of Canada and Great Britain)

CENSORED

An exclusive feature prepared by M. W. Bourdon, special correspondent of Automotive *and* Aviation Industries in Great Britain.

The Government has announced outline plans for the production of 10,000 gas producer plants for heavy trucks and buses, installation and use to be made compulsory on buses in the first instance, with operators bearing the cost of the plant and installing it. Compulsion may be applied later in the case of trucks. No official information is yet available as to the plant, but it is believed to be a modified version of one sponsored half-heartedly by the Government about a year ago—a plant that has been severely criticised in authoritative quarters. Problems concerning production facilities, servicing and fuel supplies appear still to be awaiting solution, and there is a widespread belief that the plans have been announced prematurely in response to fierce criticism of the Government in Parliament in regard to its lukewarm attitude towards gas producers in general.

* * *

A nation-wide sweep for scrap rubber has been commenced, taking in the various areas in turn; it is supported by intensive local publicity with a background of national propaganda. Garage proprietors are giving full cooperation in collecting worn tires and allowing their premises to serve as receiving depots.

* * *

Although the Government has announced its intention of commandeering the tires of passenger cars laid up through lack of gasoline or other reason, it has been stated in Parliament that the announcement does not imply immediate action of this character. Plans will be put into effect only if it is found impossible otherwise to keep essential transport operating. Meanwhile, the Tire Control Board has appealed to all owners of unused cars to offer their serviceable tires for sale to officially appointed dealers and retreaders.

BOOKS . . . .

14000 Gear Ratios, with Examples Showing Application of Tables, by Ray M. Page. Published by The Industrial Press, New York.

This book consists of tables for use in selecting gear sizes for a given gear ratio or drive ratio. It is divided into four sections. Section 1 gives the decimal equivalents of common fractions whose numerator and denominator are within the range of numbers of teeth likely to be used in gear wheels. Section 2 gives decimal ratios, their logarithms, and the tooth numbers of equivalent pairs of gears. In Section 3 are given tooth numbers of various pairs of gears having the same total number of teeth, and the ratios of these gears. Section 4 contains numbers and equivalent gear factors, including all of the numbers from 20 to 14,400 that are the product of two factors of which neither is greater than 120. This section is useful in determining tooth numbers for a four-gear train of the back-gear type that must give a certain ratio accurately. Examples are given showing the practical application of the tables. The book should prove valuable to those who frequently have to solve problems of this kind.

The

NEW ETHYL RESEARCH LABORATORIES

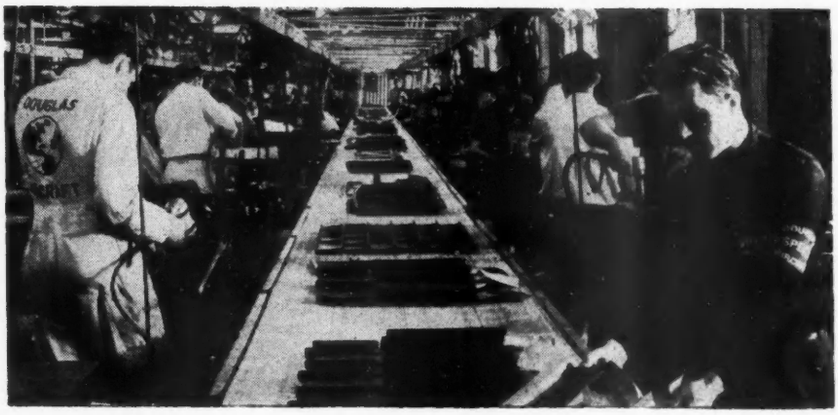
▼

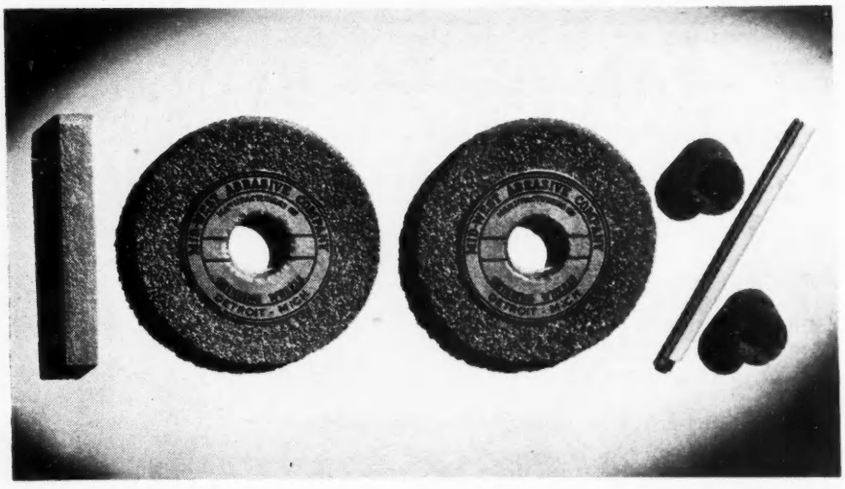
The new Ethyl Laboratories for fuel and engine research, although not quite completed, are today in "active service." Under construction when America entered the war, the 26-acre plant at Eight Mile Road, Detroit, was offered immediately to the government to aid in problems pertaining to military fuels and engines. Today, in cooperation with the technologists of the automotive, aviation and petroleum industries, Ethyl engineers are working to help give American motorized equipment the extra power, efficiency and dependability that are all-important in a mechanized war. It is our hope that the knowledge gained through this research will contribute both to victory and to the progress of peacetime transportation in the years to come. The Ethyl Corporation, New York City.

ETHYL
BRAND OF ANTIKNOCK COMPOUND
ETHYL CORPORATION
TRADE MARK REG. U.S. PAT. OFF.

Douglas Conveyor Speeds Production

Hailed as an innovation in the aircraft industry, this conveyor belt, located in a West Coast plant of the Douglas Aircraft Co., is being used in the straight-line assembly of small component parts. Necessary tools and jigs are located at the various stations along the line; no man need leave his station for supplies, and no backtracking is required, since all material is supplied from a stockroom at the far end of the conveyor.





LIKE the English merchant who "Caters to the King," we are proud to announce that virtually one hundred percent of the guns being manufactured for the United States Navy as well as a large majority of those produced for the United States Army are honed with MID-WEST honing stones.

That is a simple statement of fact but to us it means recognition of excellency by our armed forces which more than justifies the many years of research and toil and training that went into development of these highly efficient stones. We contend that we manufacture the world's finest abrasives — honing and superfinishing stones, grinding wheels, emery cloth, sandpaper — and we submit that the selection of MID-WEST stones by our Army and Navy is ample proof of that claim.

The accuracy and fire power of our big guns, as our enemies are learning, are second to none in the world and the MID-WEST ABRASIVE COMPANY is extremely proud of its contribution to that prowess. May our guns continue to fire far and true and potently until those who would destroy our way of living are themselves destroyed conclusively.

MID-WEST ABRASIVE COMPANY

Manufacturers of grinding wheels, sandpaper and emery cloth

1960 E. Milwaukee Ave. Detroit, Michigan

Mid-West

MID-WEST ABRASIVES

Limit Use of Metals in Valves

Rigid specifications for the manufacture of exhaust valves used in all types of automotive equipment have been established by the War Production Board in order to conserve large quantities of chromium and nickel.

Limitation Order L-128, effective July 1, specifies the maximum amount of chromium and nickel that may be used in the manufacturing formula for automotive exhaust valves. All manufacturers, the order provides, must use a two-piece, welded head type of construction, permitting chromium and nickel to be used in the valve head only.

Twin Disc Moves Division

New machines and new facilities are now being installed in the Rockford, Ill., plant of the Twin Disc Clutch Co. The expansion results from the creation of a separate division of the company to handle the development, production, and sale of hydraulic drives and torque converters which were formerly produced at Racine, Wisc.

Publications

(Continued from page 18)

Superintendent of Documents, Washington; or by writing to Room 1501, New Social Security Building, Washington, D. C.

The May-June issue of Metco News contains some interesting information on the latest developments and applications of the **metal spraying process**, equipment for which is produced by Metallizing Engineering Co.*

The National Bureau of Standards has just released a **Directory of Commercial Testing and College Research Laboratories.** The new directory, Miscellaneous Publication M171, may be obtained, at 15 cents per copy, from the Superintendent of Documents, Washington, D. C.

An English edition of the **ISA Tolerance System** (international system of fits) has just been published by the American Society of Mechanical Engineers, 29 West 39th Street, New York City. The price is $2.50.

Three American Emergency Standards for **statistical control of quality** have been prepared by an ASA emergency committee. Copies (75 cents each) are available from the American Standards Association, 29 West 39th Street, New York City.

* Obtainable through editorial department, AUTOMOTIVE *and* AVIATION INDUSTRIES. Address: Chestnut and 56th Sts., Philadelphia. Please give date of issue in which literature was listed.

Emergency" STEELS

ARE HERE TO ASSIST YOU IN APPLYING THEM MOST EFFICIENTLY

HERE we list the National Emergency Alloy Steels, known as the NE-8000 Series—manganese molybdenum and low chromium, nickel, molybdenum steels — developed to conserve strategic alloying elements.

Listed, too, are standard A.I.S.I. steels containing no chromium or nickel, which are also being adopted in this conservation program.

The use of these steels may require changes in established methods of fabrication, or in heat-treatment procedures, or in both. It may even require changes in engineering design. Certainly it will involve careful study in selecting these steels to suit your particular fabricating operations. We are prepared to help you meet this situation with the least dislocation of your present procedure.

It was gratifying to us of Carnegie-Illinois to be called upon to make a major contribution in the development of the National Emergency Steels. But their successful development, we believe, also entails a definite responsibility on our part to assist industry, as far as possible, in *applying* these steels successfully. This we are glad to do—and to the fullest extent of our capabilities.

U·S·S CARILLOY ALLOY STEELS

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

This foreman is responsible for annealing of steel, in a plant where annealing furnaces must run for days at an unbroken stretch. He prefers Micromax Pyrometers (on panel behind him), for controlling temperature of the furnaces because they are fully dependable as well as fully automatic; release much of his time for other work.

FOR "ALL-OUT" HELP TO BUSY MEN,

Micromax Pyrometers Guard Their Own Dependability

The Micromax Pyrometers shown above operate for days at a time without the touch of a human hand. They do so because they have, inside themselves, automatic "hands" which attend to routine needs.

Every potentiometer pyrometer, for instance, needs an occasional "standardizing," because its operating cells change in voltage as they are used. So, in Micromax, a gear train performs the standardizing operation, *automatically*. And it does this every 45 minutes—much oftener than a man would; oftener even than is necessary if the operating cells are at their best level of performance. But very new operating cells, or very old ones, or ones which have been frozen, baked or otherwise damaged, have no long-sustained level. So, Micromax takes no chances on any cell. It standardizes so frequently that any one gives good service until it's exhausted.

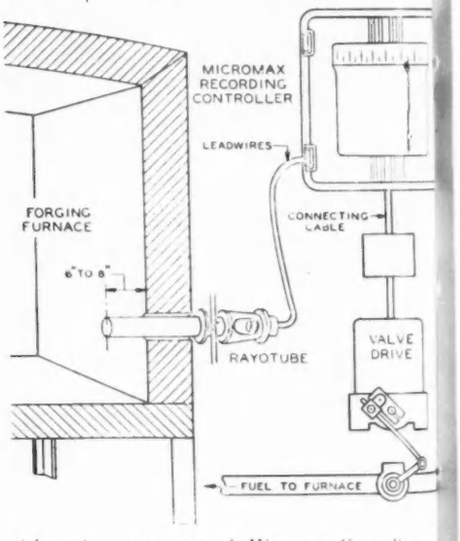
And, as a cell approaches exhaustion, a signal appears on the pyrometer, calling for attention. Similarly, advance warning is given when fresh chart is going to be needed; or more ink; and if electric power is off, thus stopping the pyrometer, that fact can be seen. And there are many other automatic "hands" in Micromax.

Not all of these features are necessary, or even advisable, for all applications, however, and for that reason we make Micromax in four models, in addition to the Strip-Chart (Model S) shown above. You can thus find a Micromax for almost any furnace-control problem. We'll be glad to help on request, in the selection.

Rayotube installed on a forging furnace, Steel Improvement & Forge Co., Cleveland.

Rayotubes Are Ideal With Micromax Pyrometers for Many Furnace-Control Jobs

Whenever a furnace's pyrometer is using a thermocouple as the temperature-sensitive element, and the couple is not giving satisfactory service, it's a good idea to investigate the use of a Rayotube. For this detector gives greatly superior results in many cases. There isn't space here to give details, but the diagram shows one specific example.



Schematic arrangement of Micromax Controlling Pyrometer, regulating temperature in an oil-fired forging furnace and using a Rayotube to detect temperature. Note that Rayotube proper is outside furnace, merely "looking" in at a closed-end target tube which is at full temperature.

The furnace is one of many, used for the heating of forging stock in the shop of Steel Improvement & Forge Co., Cleveland. Thermocouples, used in these furnaces, used to break because of vibration from the forging hammers. When Rayotubes became available, they were tried, and won on two scores. First, they don't break, burn out, or corrode; they outlast 'couples many times over. Second, they're much more sensitive than 'couples so that control of temperature is closer, quicker, more accurate.

If you have a problem in which Rayotubes possibly could serve you, see Catalog N-13B, or write us.

Jrl. Ad ENT-0600C(50)

LEEDS & NORTHRUP COMPANY, 4966 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Wage Conference

(*Continued from page 46*)

said such a raise would be automatic with each 5 per cent rise in the cost of living.

In other NLRB elections, the UAW-CIO scored victories in four aircraft plants operated by automotive companies. At the new Buick aircraft engine plant at Melrose Park, Ill., the UAW received 3883 votes to 481 for no union. At Studebaker's new Chicago aircraft plant the UAW polled 1906 votes to 314 for no union. The UAW polled 1358 votes at the new Fisher Body Memphis Division aircraft plant to 449 for no union. The new propeller plant of Nash-Kelvinator Corp. at Lansing went UAW-CIO by 1467 to 128.

Negotiations between General Motors Corp. and the UAW-CIO, which have been adjourned until July 6, are expected to set the pattern for a final settlement of contract negotiations now in progress between the union and Ford and Chrysler. Wage stabilization is an important issue at stake, as a $1-per-day wage raise has been requested of all three companies, which already pay the highest industrial rates in the U. S. The GM case, which is being heard by a three-man panel of the War Labor Board, is likely to go to the full 12-man board for a final decision.

James F. Dewey, veteran federal conciliator, entered the Chrysler negotiations June 22 after the company disputed three of the union's 13 demands. The company contended that three of the demands concerned the body of the contract, which expires Nov. 29, and not the wage section, which expired June 1. In addition to the $1-per-day wage raise and a $100 war savings bond as a bonus, payable in December, the demands against Chrysler include abolition of the 9-cent-per-hour differential between Chrysler's Detroit plants and those elsewhere; $1-per-hour minimum in all plants, abolition of piece work in forge plants, and replacement by the average rate of the last six months, plus a general increase; increase of the hourly rate for maintenance employes to $1.50 per hour, a 20 to 25-cent raise; agreement not to freeze wages for any length of time; equal rates for men and women, and an increase for all skilled trade rates, notably tool and die workers, to rates paid by jobbing shops.

Coincident with the wage demands, labor disturbances occurred at several Chrysler plants. There were short unauthorized work stoppages at the De Soto plant and the Chrysler Tank Arsenal, while at the Dodge Division employes twice insisted on working when they had been laid off. Sixty maintenance men worked a sixth day on Saturday when the corporation sought to revert to a five-day basis. Another day 243 workers insisted on working a full eight-hour shift when the corporation ordered them home after two hours' work. The union local accused the corporation of delaying conversion to war production.

In order that laid off automotive workers who have been trained for new jobs on war work by other companies will not waste their new skills, the War Manpower Commission and the WPB have effected an arrangement whereby the worker will not have to surrender his accumulated seniority if he fails to return to his old job. Amending the six-point policy statement of Sept. 17, 1941, on seniority, the agreement provides that a worker whose skill qualified him for war work without additional training must return to his old job upon seven days' notice to retain his seniority. A worker who has been fully trained by a new employer for war production shall not be required to return to his original employer prior to Jan. 1, 1943, and shall accumulate seniority with the original employer during the war emergency, unless the original employer can give him employment in an occupation in which he has been given additional training. In the latter case, he must return to the orig-

(*Please turn to page 72*)

ONLY LAPPING *As Strom Does It* CAN PRODUCE SUCH PRECISION

Strom Steel Balls possess a degree of surface smoothness and sphericity that has never been equalled in any other regular grade of ball. Such precision is exclusive with Strom because it can be attained only through a series of lapping operations such as are standard practice in the Strom plant.

Physical soundness, correct hardness, size accuracy and sphericity are guaranteed in all Strom Balls.

Other types of balls—*stainless steel, monel, brass* and *bronze*, are also available in all standard sizes. Write for complete details.

Strom STEEL BALL CO.
1850 So. 54th Avenue, Cicero, Ill.
The largest independent and exclusive Metal Ball Manufacturer

Wage Conference

(*Continued from page* 71)

inal employer within seven days or forfeit his seniority.

Four workers at the U. S. Naval Ordnance Plant at Detroit, operated by Hudson Motor Car Co., were discharged June 20 for fomenting a wildcat strike that kept 1600 workers on the day shift idle. Employment of eight Negro workers on production jobs caused the trouble which disrupted production at the huge naval arsenal. The UAW-CIO disclaimed the strike and approved dismissal of those responsible. Hiring of Negroes is in conformity with the government's fair employment policy of no racial discrimination and has been endorsed by the UAW-CIO, which condemns racial prejudice.

Change Company Name

Ferguson-Sherman Mfg. Corp. has changed its name to Harry Ferguson, Inc. Harry Ferguson will continue as president and Roger M. Kyes as executive vice-president. The company markets Ford tractors and agricultural equipment which utilizes the Ferguson system of linkage and hydraulic control.

HOW MANY MILLIONS OF VIBRATIONS

Must An Aircraft FUSE Withstand!

AIRCRAFT LITTELFUSES ANTI-VIBRATION TYPE!

LITTELFUSE 90° TWIST

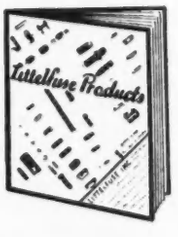
LITTELFUSE GOOSENECK

are built to give dependable service until they blow—not disintegrate! And for LITTELFUSE reasons. Littelfuse elements twisted at 90° is one of them. This twist braces them against most severe vibration. Another is the Littelfuse "Goose-neck" spring - like forming that takes up contraction and expansion, preventing crystallizing and cracking of fuse element at fusion point. Another is the Littelfuse Locked Cap Assembly (Patented). Caps are *locked*, not cemented on. Caps with markings will not be lost. Littelfuse Process seals fuse and protects from moisture.

Heavy Duty Aircraft Littelfuse 150 to 300 Amps.

SEND FOR COMPLETE CATALOG

We make fuses for all aircraft purposes—high and low voltage—instrument, radio, automobile, and auto radio fuses — mountings, clips, including the triple-grip Littelfuse Be. Cu. Clips — mountings, panels, Tattelite Pocket Electrical Testers, etc.



LITTELFUSE INC.

"First in Aircraft Fuses—Pioneer in the Industry"

4731 RAVENSWOOD AVENUE, CHICAGO, ILLINOIS

201 ONG STREET, EL MONTE (LOS ANGELES SUBURB), CALIFORNIA

Aeronautical Institute Receives Gifts

Two gifts, one from Glenn L. Martin, and the other from Mrs. Daniel Guggenheim, were received recently by the Institute of the Aeronautical Sciences.

Mr. Martin's gift, known as The Minta Martin Aeronautical Endowment Fund, and consisting of 25,000 shares of stock in The Glenn L. Martin Co., was received shortly after Mrs. Guggenheim's donation, a memorial to her husband, of her estate near Port Washington, Long Island. The 160-acre plot, embracing a large residence and other buildings, will be used as a center for aeronautical research.

Awarded Dudley Medal

For their technical paper presented at the 1941 annual meeting of the American Society for Testing Materials describing in detail extensive studies on the measurement of water vapor and gases, F. C. Todd, assistant professor, petroleum and natural gas engineering, and A. W. Gauger, director of mineral industries research, both of Pennsylvania State College, received the Charles B. Dudley Medal at the annual meeting of the ASTM in Atlantic City on June 24.

Plastic Drill Jigs

(*Continued from page* 41)

pour plastic into a mold when the lacquer is not dry; (d) don't put a lacquered mold in the oven immediately after spraying; (e) don't use shellac on molds; (f) don't cast around metal inserts without immunizing; (g) don't experiment with actual tools; (h) don't mix the different types of lacquers or thinners.

Baking

The baking time depends upon the size of the castings. It also depends upon the type of mold used and the thickness of the material used in the making of the mold. The following table is to be used only as a guide and not as a strict rule. It is based on the actual baking time of the plastic and does not include the time necessary for the heat to penetrate the molds. The baking temperature is 175 deg. F.

Castings up to 1 gal.	2 hr.
Castings 1 to 2 gal.	3 hr.
Castings 2 to 4 gal.	3½ hr.
Castings 4 to 8 gal.	4 hr.
Castings 8 to 12 gal.	6 hr.
Castings 12 gal. up	8 hr.

If a casting is soft and pliable when it is taken from the mold, it is still green. It should be taken from the oven. If a casting is pulled green and put back into the oven to cure, it is likely to get soft, pull out of shape and set in that position. Be sure the casting is cured

THE CENTER OF ATTRACTION

With

MOTOR TOOL LIVE

Ball and Roller Bearing CENTERS

Machine tool operators give slight thought to the little center which holds the work on their lathe or grinder or milling machine ..... *until it burns out or breaks down.* But .... WHEN PRODUCTION STOPS .... it looms up BIG in importance.

Motor Tool Live Centers stand up and stay steadily on the job under the heat of highest speeds. In their long and useful lives, R.P.M. means only *Repeat Performance Maintained.* Scientifically designed and built under the watchful eyes and skillful hands of experts, they roll with the work on both ball and roller bearings . . . keep cool . . . and keep going . . . under the stress of heaviest production overloads.

Try one in your plant. Test it alongside other centers. Give it a real workout. You'll know then why Motor Tool Live Centers *keep 'em spinning* . . . and you'll have reason to remember the center you can completely forget.

FEATURES

Simple Design . . . Heavy Duty . . . Greater Radial and Thrust Load Carrying Capacity . . . Large Spindle . . . Small Head . . . Short Overhang . . . Locking Feature for Redressing Point without Disassembling . . . Oil Seal Lubricant Retainer . . . Compensation for Expansion of Metal.

MOTOR TOOL MANUFACTURING CO.

METAL CUTTING TOOLS

7775 CORTLAND AVENUE • DETROIT, MICHIGAN

"Make it a Rule to Call Motor Tool"

Mitsubishi Kinsei Engine

(*Continued from page* 25)

bronze valve guides are used in both sets. Port diameters are as follows: Intake, 2.24 in. at valve end, 2.16 in. at opposite end; exhaust, 2.18 in. at valve end, 2.26 in. at opposite end.

The pistons are aluminum-alloy forgings and similar to those used in current American practice. The Brinell hardness of 100 is quite uniform. Pin bosses are drilled for splash lubrication. Heads are flat, with no valve-clearance cut-outs. The under side of the head is ribbed at right angles to the piston-pin bore. The piston is fitted with six 0.090-in. rings in five grooves. The two upper ones are flat-faced compression rings, chromium-plated on the outside diameter to a depth of 0.0007 in. The third is a tapered-face compression ring installed with the scraping edge down. There are two scalloped oil-control rings in the fourth groove. The fifth ring, below the piston pin, is a typical 45-deg. oil scraper. A relatively narrow land (0.23 in.) is provided above the upper compression ring. The next two lands are 0.17 and 0.14 in. wide, respectively. Scraper rings are fitted closely (0.001 in. in the fifth groove and 0.003 in. in the fourth), with progressively increasing clearances toward the piston head. All rings have parallel sides and approximately 0.200 in. radial depth. The piston pin is of low-alloy steel, through-hardened to Rockwell C-42.

The cam is a double-track ring running on a tin-bronze cast bushing, which in turn is a push fit on a ledge of the crankcase intermediate front-section diaphragm. It is case-hardened to Rockwell C-60. The core hardness is Rockwell C-32. The drive is through a pair of spur gears from the crankshaft to the intermediate cam drive. This intermediate cam drive is mounted on a stub shaft on the crankcase front main diaphragm, and is made as a cluster gear incorporating a pinion which drives the internal gear integral with the cam. A bronze bushing in the cluster gear completes the assembly. No lock is provided on the screw which retains this gear, as the right-hand thread tends to tighten in operation. This gear train provides for cam rotation at one-sixth crankshaft speed and in the opposite direction. Three lobes on each cam track provide for operation of all 28 valves. Cam lobes and tappets are tilted 14 deg. 30 min. to approach straight-line action of the pushrods and tappets.

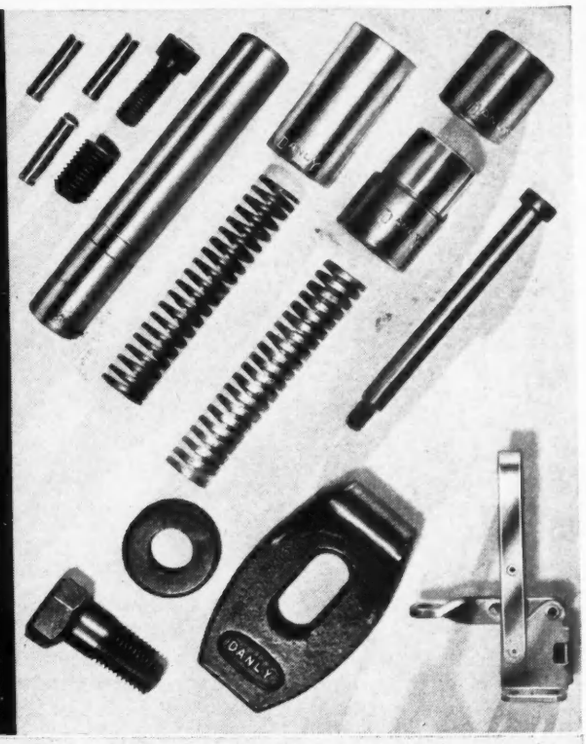
The cam is designed with constant-velocity pick-up and seating ramps for a running clearance of 0.045 in. At 2000 r.p.m. the pick-up and seating velocity of all valves is 1.95 fps. Valve timing is approximately as follows: Inlet opens 20 deg. early and closes 64 deg. late; exhaust opens 80 deg. early and closes 30 deg. late. Valve lift is 0.54 in.

Tappets are arranged in pairs in 14 guides of 17S aluminum alloy. They are bored and slotted elaborately for oil feed, drainage, etc. They are 0.62 in. in diameter, treated to Rockwell C-61 hardness, and are fitted with pressed-in ball sockets for pushrod operation. Tappet rollers of 1.25-in. diameter show Rockwell C-61 throughout and are mounted on case-hardened (Rockwell C-60 case, C-30 core) floating pins of 0.31 in. diameter. Pushrods are low-chromium-alloy tubing with pressed-in ball ends of low-alloy steel, heat-treated to Rockwell C-30, except at the tip, which is quenched to show C-60. Pushrod housings are aluminum alloy and are secured by means of a packing-gland type of joint to the cylinder rocker box.

Valve rockers are cadmium-plated steel forgings and oscillate on pressure-lubricated plain tin-bronze bushings pressed into bores in the arms and pinned. They ride on a flanged steel journal supported by a stepped rocker bearing bolt. Rocker thrust is taken by the bushing flange against a shoulder on the journal. The pushrod ball

PRECISION
IN DIMENSIONAL ACCURACY
IN DAILY PERFORMANCE

DANLY
PRECISION
DIE
MAKERS'
SUPPLIES
—
DOWEL PINS
SCREWS
SPRINGS
POSTS &
BUSHINGS
CLAMPS
—



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3913 North Broad Street, Philadelphia, Penna.
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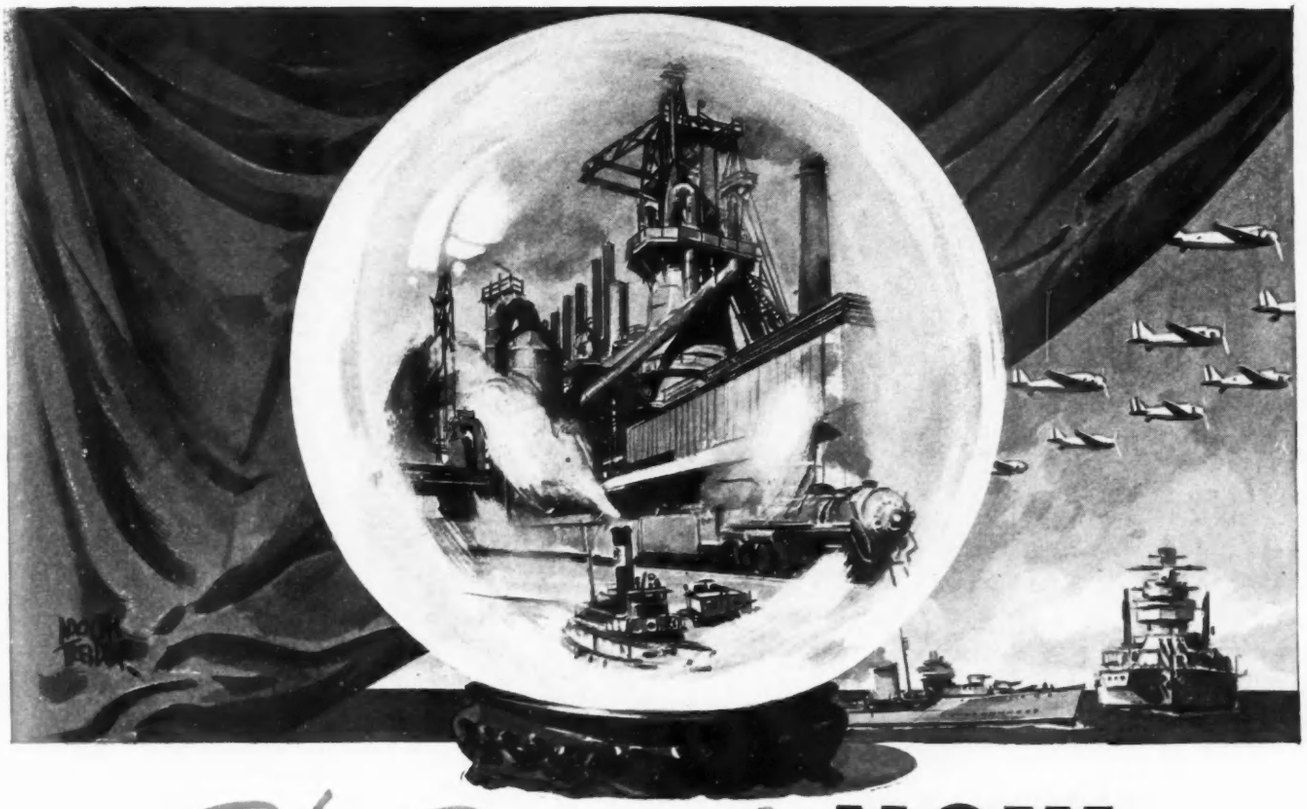
DANLY DIE SETS and DIE MAKERS' SUPPLIES



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THE NILES TOOL WORKS CO.

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Mitsubishi Kinsei Engine

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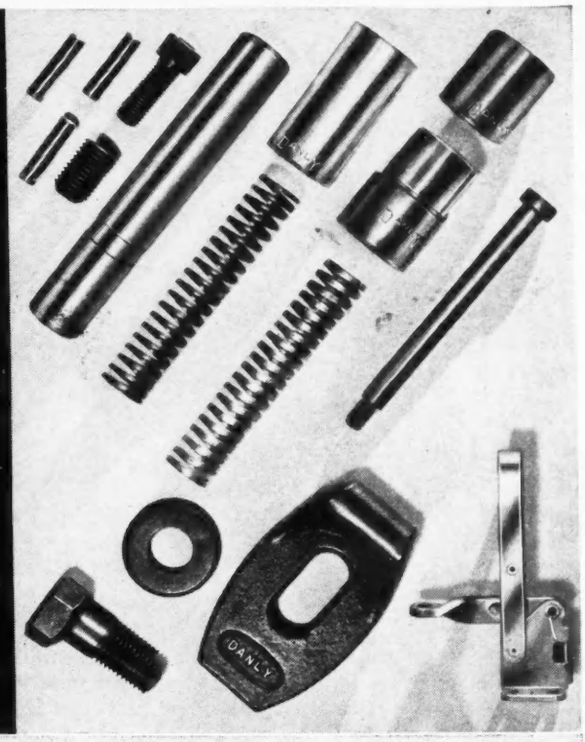

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GENERAL MACHINERY ORDNANCE CORPORATION

socket is permanently secured in one end of the rocker. Adjustment, by means of a screw, is at the valve end.

Hollow-head-and-stem exhaust valves and the familiar tulip-head, solid-stem intake valves are used. The exhaust valve steel is the high-chromium, high-nickel plus tungsten and cobalt alloy generally used in this application. It is forged and machined in one piece with welded stellite tip and face. Face and tip hardness is Rockwell C-56; stem, Rockwell B-96; and head, Rockwell B-93. Metallic sodium is used as a coolant. The inlet valve is a familiar material with 13.2 per cent tungsten, 3.2 per cent chromium, 0.8 per cent nickel, 0.1 per cent cobalt, 0.4 per cent manganese, 0.4 per cent silicon and 0.5 per cent carbon. It has a hardness of Rockwell C-35 to 45 with the tip hardened to 55. Major valve dimensions are as follows: Exhaust, 2.53-in. diameter head, 45-deg. face, 0.62-in. stem; intake, 2.67-in. diameter head, 45-deg. face, 0.43-in. stem. Two springs are used per valve, the inner seating on a washer on the guide flange, the outer on a loose steel washer in the cylinder. Springs are cadmium-plated carbon steel of Rockwell C-40 hardness.

The propeller reduction gear (0.70:1) is of the planetary type. A large internal gear with 84 teeth is splined to the crankshaft front extension. A flange is formed integral with the splined hub, and to it the internal ring gear is secured by a large number of small "through" bolts. The roots and flanks are Rockwell C-62, the core hardness (including tips) is C-26. The 36-tooth sun gear of this set is secured to the crankcase front section by through bolts. Roots and flanks of this gear are Rockwell C-60; the core hardness, including tips, is C-38. Six 24-tooth planet pinions are mounted on trunnions pressed into a machined-out split cage. Pinion roots and flanks are Rockwell C-59, while the core hardness (including tips) is C-41. The case depth is 0.045 in. Trunnions are of low-alloy steel, carburized on the journal surface only to Rockwell C-59 on the case and C-42 on the core, with a depth of case of 0.035 in. The pinions run on pressed-in, steel-back, copper-lead-lined bushings.

The pinion cage is splined to the propeller shaft and retained by a large nut. The propeller shaft is through-hardened to Rockwell C-59. It has involute splines cut on it—22 standard and one wide splines cut on the basis of 24. These splines have an outside diameter of 3.725 in. and a depth of 0.135 in. Cone-seat diameters are 3.735 in. for the large cone and 3.228 in. for the small. A 1-in. wide undercut is machined between the latter and the spline ends. Propeller-nut threads are 80 mm. in diameter and have a 2.5-mm. pitch.

The gear-driven centrifugal supercharger turns at 8.48 times crankshaft speed. A number of purposes are served by the main accessory-drive-and-starter shaft, driven through a splined coupling from the rear main journal and running in a bronze bushing in the supercharger rear cover. The hub for a spring-loaded supercharger-drive gear is formed integral with this shaft. The impeller shaft rides on two steel-backed, copper-lead-lined bushings on journals of this shaft. The shaft has a core hardness of Rockwell C-40 and a case hardness of C-55 at wear points. A case-hardened cluster gear and pinion, mounted on a shaft fixed in the supercharger rear housing, and piloted in a bushed bore in the supercharge rear cover, complete the single-speed supercharger drive. This intermediate drive cluster incorporates a copper-lead-lined, steel-back bushing. The impeller, of 17S aluminum alloy and 9.62 in. in diameter, is mounted on square splines on its shaft. Impeller design (12 vanes) is conventional. A 14-vane diffuser plate of magnesium alloy is secured to the rear-housing flange by 14 screws. Fourteen intake pipes are taken tangentially from the annulus formed between the supercharger front and rear housings, the oil baffle plate and the diffuser plate. Oil sealing is effected by four cadmium-plated, cast-iron piston rings in space

MOTOR TEMPERATURE CONTROL FOR THE

ENGINES OF WAR

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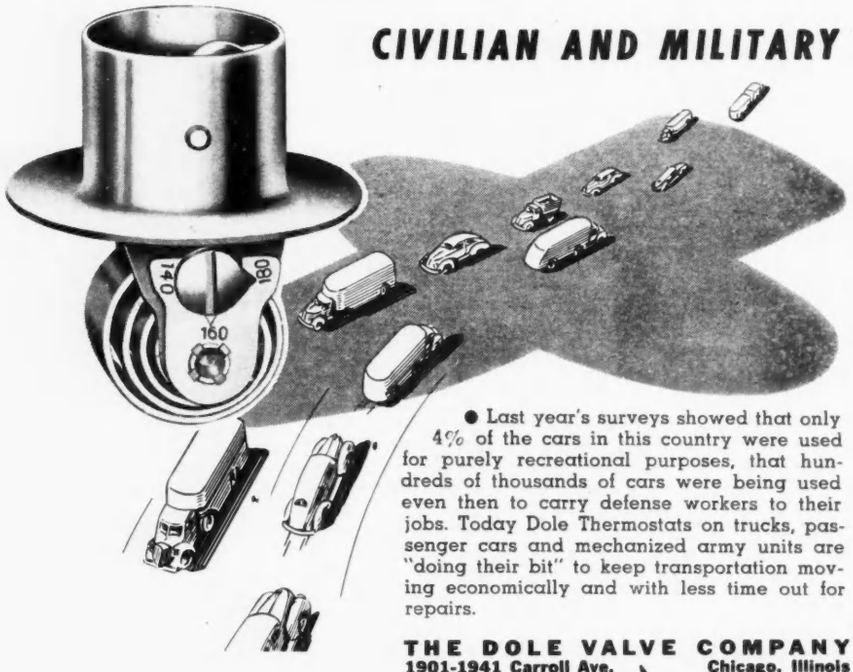

● Last year's surveys showed that only 4% of the cars in this country were used for purely recreational purposes, that hundreds of thousands of cars were being used even then to carry defense workers to their jobs. Today Dole Thermostats on trucks, passenger cars and mechanized army units are "doing their bit" to keep transportation moving economically and with less time out for repairs.

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DROP FORGINGS WILL "WITHSTAND THE UNPREDICTABLE"

"These weapons of war are very different from the products we have been building over the past years. They are subject to more severe stresses, strains and shocks. They must be built to withstand the unpredictable."

O. E. HUNT, *Engineer*
General Motors Corporation

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CHAMBERSBURG ENGINEERING CO., CHAMBERSBURG, PA.

grooves in the shaft at each end of the impeller. The rings seal against steel sleeves tightly fitted into the supercharger rear housing and the crankcase oil baffle plate.

A 50-tooth, spring-loaded accessory-drive gear drives all of the accessories (except the magnetos) through a centrally located 19-tooth idler gear from which are driven a 29-tooth generator-drive gear and shaft, a 40-tooth oil-pump drive gear and shaft, and a 40-tooth accessory gearbox drive gear and shaft. An 8-tooth spiral gear is machined on the oil-pump drive shaft and meshes with a 9-tooth spiral gear on the fuel-pump drive shaft, driving the fuel pump at 1.11 crankshaft speed. The square shaft and square pad formerly standard on American engines are used for the fuel-pump mounting. Magnetos are driven from a 30-tooth spur gear integral with the crankshaft extension, through an intermediate magneto drive shaft which turns in two bronze bushings in the supercharger rear cover.

A three-section oil pump comprising a pressure pump and two scavenge pumps is mounted on the rear cover. Oil from the pressure pump is taken through passages in the supercharger rear housing and a disk type oil strainer to the large bronze bushing in which the anti-propeller end of the crankshaft extension runs. Oil transfer to the drilled crankshaft extension is accomplished through slots in the bushing and drilled holes in the shaft journal. All forward engine lubrication is taken through this journal and on through the drilled passages in the crankshaft. Knuckle-pin oil is bled from the master rod bearing clearance through holes drilled near one end of the bearing. These holes in the shell connect holes drilled in the rod flange and thence to corresponding holes in the hollow knuckle pin. Piston-pin lubrication is by splash. Holes for this purpose are drilled in the articulated rod eye near the shank and in the bottom of each pin boss in the piston.

Reduction-gear oil is taken from the hollow front crankshaft journal and propeller shaft through holes in the splined mount for the pinion cage and on through drilled passages to the hollow pinion trunnions.

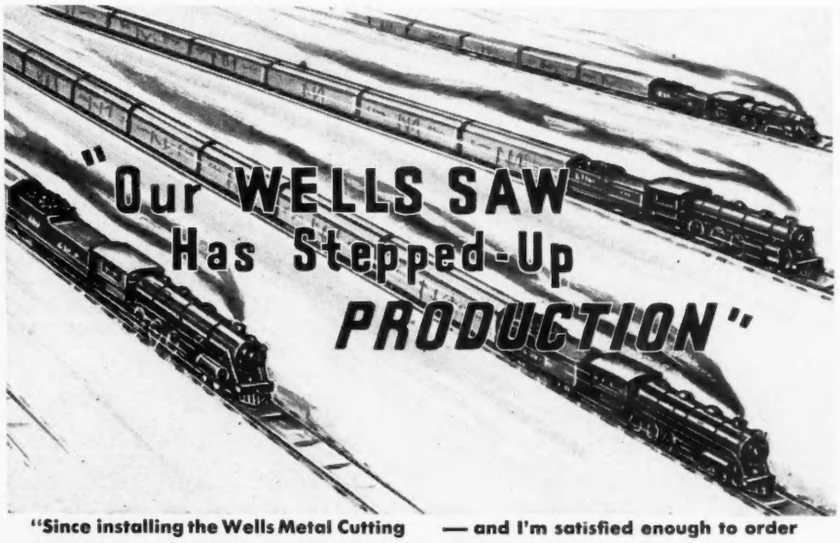
Valve gear lubrication is through a ring-sealed sleeve and a spring-loaded tube to the intermediate cam drive gear bracket, thence through a slip joint to the crankcase front intermediate section diaphragm and drilled passages therein to the cam ring and valve tappets. Pressure oil is metered to all plain rocker bearings through passages in the tappets, push rods, and valve rockers.

Brown-Lipe-Chapin Machine-Gun Plant

(*Continued from page* 21)

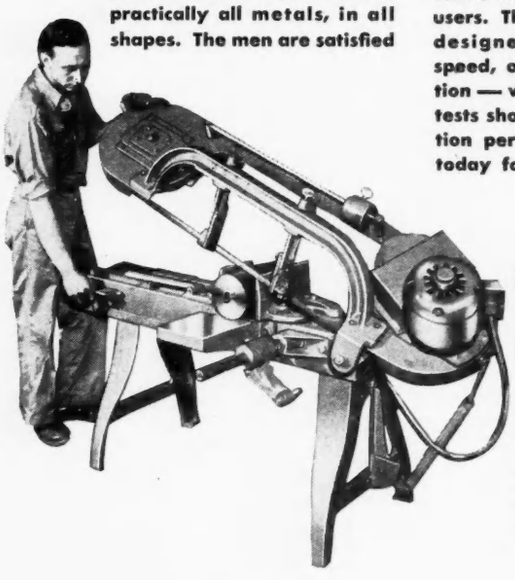
Needless to say, the barrel is easily one of the most difficult components to produce, requires the most advanced metal cutting practice. An interesting development in this department is the adoption of the new Sheffield air gage for inspecting the barrel bore. This makes it possible to explore the entire length of the barrel for size, eliminating the human equation. Another of the modern inspection devices employed here is the well-known J & L Comparator which is used for the inspection of certain intricately formed components.

In retrospect it may be noted that Brown-Lipe-Chapin has developed one of the most outstanding facilities for the production of ordnance materiel with mass-production techniques. It is a fine example of automotive methods at work to expedite the manufacture of items that heretofore were made only in modest quantities. The record shows that this organization has beaten its early contract schedule and has established an enviable level of achievement both in quality and productivity.



"Since installing the Wells Metal Cutting Band Saw our records show increased production. It quickly cuts practically all metals, in all shapes. The men are satisfied — and I'm satisfied enough to order another."

That's the talk we hear from Wells users. This fast, sturdy, metal cutter, designed for today's productive speed, operates with minimum friction — without coolants. Long run tests show less than .005 inch variation per hundred samples. Write today for full information.



Wells SAWS

SPECIFICATIONS

WELLS No. 8

Capacity: Rectangle	8" x 16"
(spec. bowed guides)	5" x 24"
Rounds	8" dia.
Speeds: ft. per min.	60, 90, 130
Motor	Specifications optional

WELLS No. 5

Capacity Rectangle (spec. bowed guides)	5" x 10"
Rounds	5" dia.
Speeds ft. per min.	60, 90, 130
Motor	Specifications optional

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DEPENDABLE!

You may have seen them work—those dependable dogs that tire out a good 16-gauge gun in the Fall. And they're not forgotten just because June and July are not times when we in North America can put them on the job for which they were bred and trained.

So we remind you of dependable, tireless **PUSH-PULL CONTROLS**—positive, rattle-free controls—the moving part sealed in lubricant—in days when passenger cars and motor trucks are out "for the duration." Tractors, carrier-scrapers, shovels, cranes and the like also have places for them. Remember that. And when Victory brings its peace you will find **PUSH-PULLS** in top form—trained to the minute—ready for you then as they are today for those whose production makes it possible to use them.

PUSH PULL

AUTOMOTIVE CONTROLS

AUTOMOTIVE AND AIRCRAFT DIVISION

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TRADE MARK ACCO

AMERICAN CHAIN & CABLE COMPANY, Inc.

BRIDGEPORT • CONNECTICUT

MEN and MACHINES

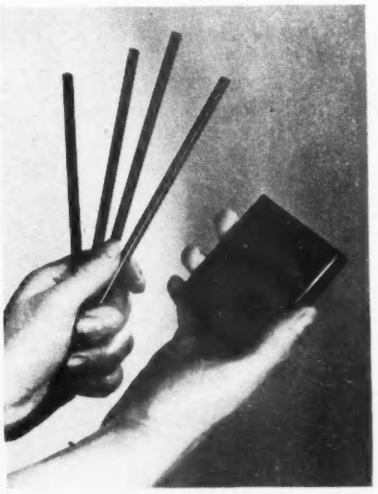
(*Continued from page* 44)

nounced the development of improved methods for handling these operations on a safe basis.

Removal of dirt, oil, and fabricating greases from the aluminum and magnesium parts before heat treating is said to be readily accomplished simply by immersing the parts for a certain period in a tank charged with a solution of Oakite Aviation Cleaner at a strength of four ounces per gallon of water. The temperature of the solution is held between 170 and 212 F, depending upon conditions. Usually immersed for a period of five minutes, depending somewhat on the amount of oil present, the parts are finally rinsed in running water.

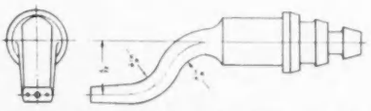
After heat treating, it is reported, discolorations may be completely removed by immersing work from two to fifteen minutes in a solution of Oakite Compound No. 84-A in a concentration of eight ounces to each gallon of water at 180 F. In cases where oil and grease are present as well as the heat-treating film, work is pre-cleaned in a solution containing Oakite Aviation Cleaner.

According to the manufacturer, these methods may also be used to (1) degrease aluminum parts before anodizing, (2) prepare aluminum alloy structures for resistance spot welding, (3) remove anodizing film from rejected aluminum parts, and (4) to strip anodizing coatings from racks, straps, hooks, etc.



According to a recent report a new synthetic rubber produced from Ameripol by The B. F. Goodrich Co., Akron, Ohio, will withstand temperatures 100 F. higher than the best hard rubber made from natural crude.

TWO additions to its line of oxy-acetylene cutting tips have been announced by Air Reduction, New York, N. Y. The first, known as Style 108, is bent in an offset shape to permit cutting along a line 21/32 of an inch from the vertical centerline of the torch head or barrel. Particularly adaptable to cutting operations in restricted space, the new head provides two preheat flames and is suitable for either machine or hand cutting operations.

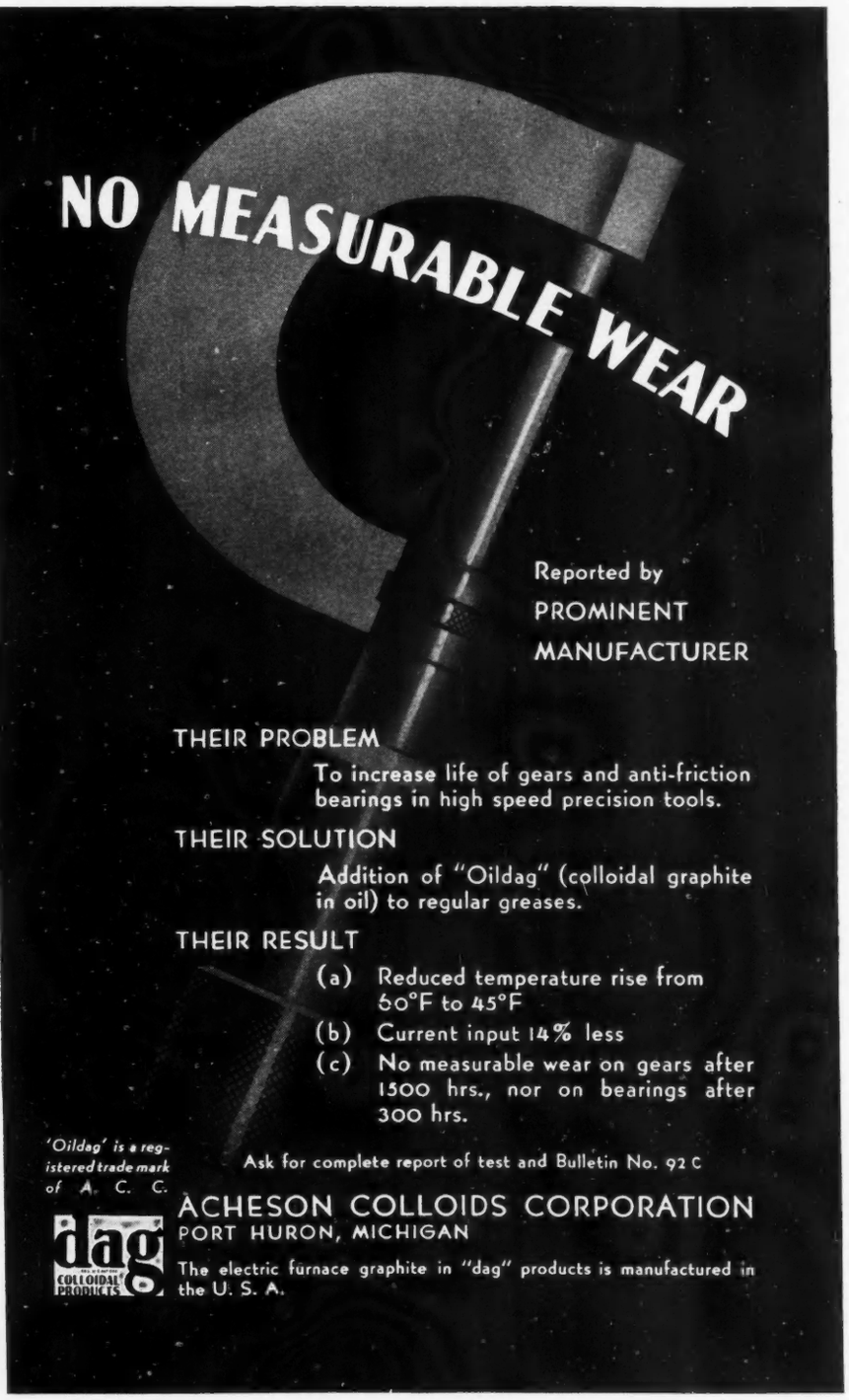


Airco offset cutting tip for work in close quarters.

The other addition, Style 139 straight tip, is a companion to Style 119. Equipped with one preheat flame, the new tip is especially adaptable to splitting angle iron, straight-line-cutting operations, or sheet-metal-cutting operations requiring a light preheat.

Each tip is available in sizes from No. 1 to No. 3.

SEVERAL new Phenolic molding compounds have been developed by Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y. One, known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PROMINENT
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To increase life of gears and anti-friction bearings in high speed precision tools.
THEIR SOLUTION
Addition of "Oildag" (colloidal graphite in oil) to regular greases.
THEIR RESULT
(a) Reduced temperature rise from 60°F to 45°F
(b) Current input 14% less
(c) No measurable wear on gears after 1500 hrs., nor on bearings after 300 hrs.
'Oildag' is a registered trade mark of A. C. C.
Ask for complete report of test and Bulletin No. 92 C
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The electric furnace graphite in "dag" products is manufactured in the U. S. A.

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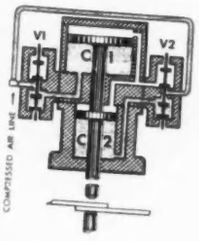
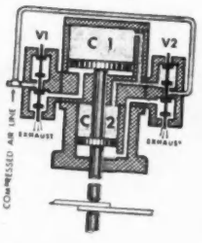
SCIAKY VARIABLE PRESSURE CYCLE

How it Operates

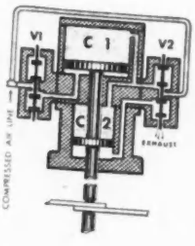
The variation of electrode pressure in the Sciaky Welding Process is effected by two air cylinders of different cross sectional areas (C-1 and C-2), mounted on upper arm of machine. Dual electro-valves (V-1 and V-2) control their action. Duration of each stage in the cycle is governed by precision electric controls.



1. REST POSITION. Electrode retracted. Both electro-valves are de-energized which permits air pressure to be exerted on the under side of pistons in both cylinders, thus lifting the electrodes.

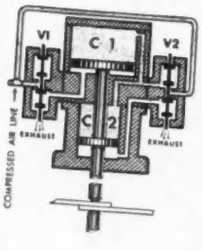


2. PRE-COMPRESSION. Both electro-valves are energized, admitting air pressure to the top of the pistons in both cylinders, thereby forcing the electrode downward with maximum pressure.

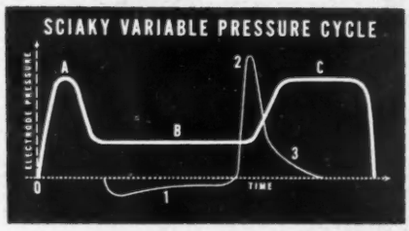


3. WELDING PRESSURE. Left electro-valve is de-energized. Pressure is maintained on top of piston in lower (smaller) cylinder, while air is admitted to under side of piston in upper cylinder. This neutralizes the downward pressure in the upper cylinder, and reduces the effective electrode pressure to about one-third of maximum.

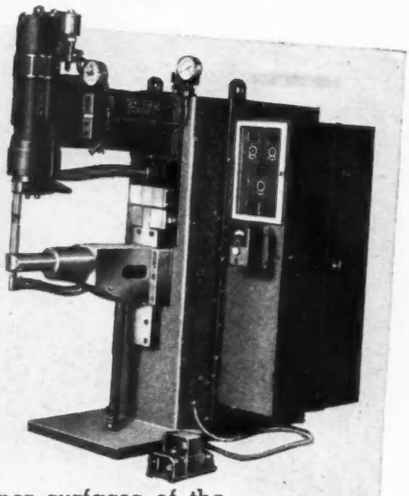
4. RECOMPRESSION. Both electro-valves are again energized. The neutralizing (upward air pressure) on under side of piston in upper cylinder is exhausted almost instantaneously, restoring the electrode pressure to maximum —the same value as during pre-compression.



SCIAKY* WELDING PROCESS "FORGES" THE METAL AFTER THE WELD....



Precompression (initial contact pressure) is indicated at A. Welding (reduced) pressure at B, and Recompression (forging pressure) at C. Electrical current is indicated by light line. During storage of energy period (1) the metal is preheated. The surge of current to maximum (2) effects the weld, and decays, (3) following the exponential curve.



Type PMCO2S-16 Sciaky Stored Energy Electric Resistance Spot Welder

In spot welding any metal, the inner surfaces of the pieces being joined are converted from a solid to a molten state at the point of passage of the welding current. This conversion in aluminum and its alloys requires a very high temperature which results in expansion of the metal in the molten zone.

The subsequent cooling of this zone is extremely rapid because of the high thermal conductivity of aluminum, and also because the artificial cooling of the copper electrodes with which the aluminum at high temperatures would otherwise tend to alloy. This rapid cooling causes sudden contraction of the weld nugget and the consequent cracks and internal stresses tend to weaken the weld.

The Sciaky Process embodies exclusive features to compensate for these undesirable conditions. In addition to pre-heating, which offsets the high thermal conductivity of aluminum and in consequence slows down the cooling process, Sciaky provides the added protection of a "forging" pressure to offset the metal shrinkage. Thus the Variable Pressure Cycle combines with the Stored Energy Principle and the exclusive pre-heating feature to insure welds of sound metallurgical quality.

As a result, the Sciaky Welding Process is preferred by practically all major manufacturers of air craft.

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Manufacturers of a Complete Line of D-C and A-C Electric Resistance Welding Machines

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*Pronounced See-ack-ee

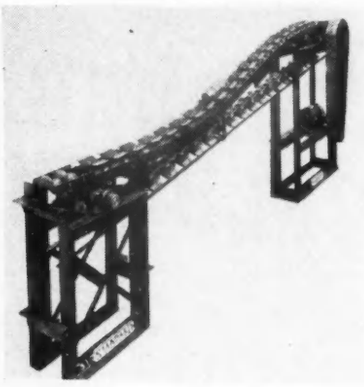
SCIAKY

PROCESS ELECTRIC RESISTANCE WELDING
STORED ENERGY • VARIABLE PRESSURE

as Durez 11863, is especially suited to the fabrication of radio parts such as condensers, crystal holders, etc. Providing high dielectric breakdown and fatigue characteristics, the new plastic is said to possess excellent moldability. It is available in only the natural color.

The other, known as Durez 11934, is a high-impact plastic designed to fill the demands for substitutes for vital materials. Since this material has a macerated fabric filler, it is not readily performed, yet it is said to have an excellent cure cycle for a material of this type. It is available in either of two colors: black or brown.

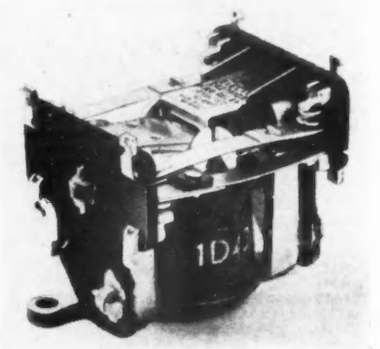
SPECIALLY designed to meet war demands for faster cycles in reverse-current cleaning of cold-rolled-steel parts before finishing, a newly-developed alkaline-type material has just been announced by the Technical Research Laboratories of Oakite Products, Inc., New York. Known as Oakite Composition No. 90, this new material is reported to provide several original features. Because of its high conductivity, adaptability to hard water conditions and fast wetting-out action, the material is said to remove efficiently oil, grease and polishing and buffing compounds.



Equipped with V-shaped, rubber-faced pallets, this conveyor, built by the Standard Conveyor Co., North St. Paul, Minn., is especially adapted to the handling of shells.

STRESSING the importance of maintaining high worker efficiency during the summer months, the Morton Salt Co., Salt Tablet Division, Chicago, Ill., is encouraging the installation of salt tablet dispensers near drinking fountains and in other accessible locations. The company recommends the use of 10-grain tablets, approximately the size of an aspirin tablet, which can be swallowed whole with a drink of water. Thus a worker by taking between 4 and 15 tablets within an 8-hour day (the dosage depends on the type of work) can be assured of freedom from the effects of heat sickness or heat cramps.

A NEW four-pole relay, designated CR2791-G100K, has been added to the line of General Electric control devices for aircraft applications. The new light-weight relay is said to provide permanence of contact position and assurance of operation under severe vibration. It has a maximum continuous rating of 10 amperes at 12 or 24 volts direct current, and a maximum make or brake current rating of 50 amperes at 12 or 24 volts. The relay weighs 0.281 lb, draws 1.80 watts and is fitted with contacts having a maximum travel of 3/64 in.



General Electric four-pole aircraft relay.

Grommets
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Weatherstrips

● Resiliency, flexibility, sound-deadening, compressibility, water-resistance—These are not exclusive properties of rubber. As rubber scarcity forces redesign of civilian products and military equipment, many new applications for Western Felts have been found.

Treated or special felts have come out of Western's research laboratories to meet specified requirements with complete satisfaction. Check over your product, and its needs. Use the engineering and manufacturing facilities of this established leader in the felt industry.

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SURVEY SHOWS:

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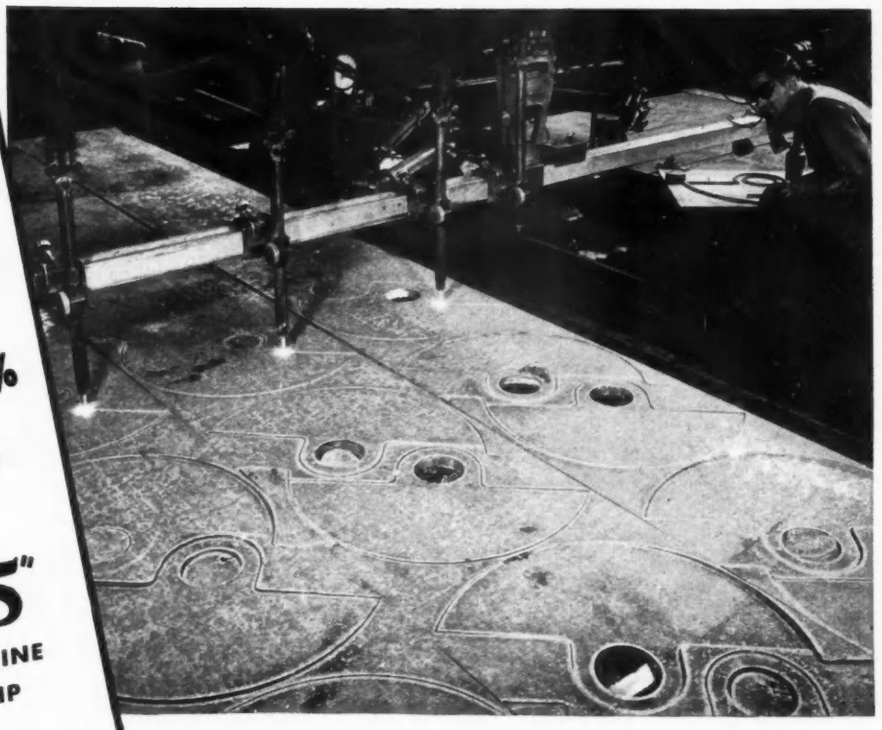
SAVING IN OXYGEN

21.1% to 28.8%
FASTER CUTTING

WITH
Airco "45"
HIGH-SPEED MACHINE GAS CUTTING TIP



Improved performance with Airco "45" tips over standard machine gas cutting tips

Metal Thickness	Average % increase in cutting speed	Average % savings in oxygen consumption
½"	21.1	14.2
1"	22.2	24.0
2"	25.8	39.5
3"	28.8	45.2

Figures shown are averages obtained in survey recently completed in Philadelphia area.

Additional proof of the outstanding performance of the new Airco "45" High-Speed Machine Gas Cutting Tip was obtained in a survey of representative plants in the Philadelphia area. On steel thicknesses of ½" to 3" a direct comparison with previous results was obtained. The results of this survey are tabulated here. Note that in addition to increasing metal cutting speeds, Airco "45" Tips make possible considerable savings in oxygen . . . a most important consideration in our country's united war effort.

Get complete details by writing for Bulletin ADC-631.

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AIRCO WILSON

IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*

Mass Production in the Manufacture of War Materials

(*Continued from page* 35)

automotive factory executives have combined to revolutionize the art. It must be remembered that during several decades of peace-time activity, the making of ordnance materiel has been the responsibility of the Army arsenals. Ordnance specialists have been developing and improving the design of weapons and ammunition, have been creating standards and specifications, but they had little opportunity to experiment with new methods of manufacture, particularly in the field of mass-production.

Consider the experience of General Motors with its machine gun contract. At the start, experimental production and training of workers was done with old equipment salvaged out of the arsenal stores. But as the picture developed and as the skilled production men began to study the problem, they found many ways in which machine guns could be built quicker and better and at lower cost than ever before. Fortunately, in these initial studies, GM was encouraged and assisted by ordnance officers, permitted to make departures from established practice of long standing.

Out of this came some striking contributions adapted directly from automotive experience. One example was the introduction of the W. F. & John Barnes vertical, six-spindle rifle drilling machine which handles six barrels at a time and increases the output of barrels manyfold. This was followed by a study of the application of Carboloy-tipped tools for rifle-drilling, promising not only a further increase in productivity but longer tool life and less interruption of machine output due to tool grinding.

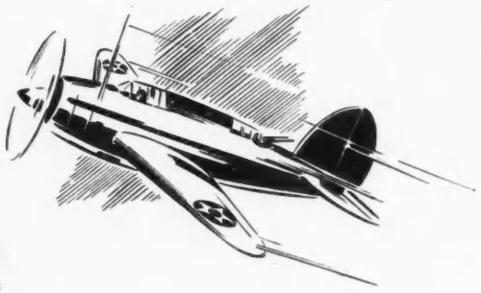
Similarly, there came the introduction of the twelve-spindle, vertical, Baush rifle-reaming machines, designed to expedite the reaming of barrels. Still another major advance was the development of a horizontal broaching machine by Illinois Tool Works, for producing barrel rifling by broaching. This procedure cuts the rifling time to but a fraction of previous practice.

It is our understanding that rifling by broaching stems from work done by the Government arsenals some years ago, paving the way to mass production set-ups under present conditions. One of the most recent applications of this technique is the big American horizontal broaching machine used for rifle-broaching the Oerlikon gun barrel. Here the job is done in a space of but a few minutes using a series of four individual broaching tools.

Surface broaching has been adopted for a number of detail operations, greatly simplifying such operations. Multiple-spindle drilling and tapping machines, heavy-duty milling machines, and other types of equipment familiar in automotive plants have been applied in an effort to speed output.

Materials handling is quite conventional, taken right out of the book of rules of the GM plants. Another innovation was the use of Baird tumbling barrels lined with Neoprene for tumbling the small components of the machine gun to remove burrs, and to break sharp edges. This eliminated the conventional practice of hand filing and grinding and polishing—again saving time and labor.

Budd and General Motors furnish good examples of advanced practice in making shells in huge quantities. Each one features modern production equipment familiar in automotive plants. Both use induction heating to speed up the heating of the billets—Budd using its unique induction process, GM using Ajax induction furnaces. At GM will be found compact machine lines reminiscent of passenger car practice, with monorail conveyors for transporting billets to the forge departments, for



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PLANES into MASS PRODUCTION

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Prime and sub contractors faced with the tremendous aircraft production goal will find help in ACP's years of experience.

DEOXIDINE, the acid cleaner that made the all-steel automobile body possible in mass production is now aiding in the mass production of aircraft. Prepares steel, aluminum and dural for painting, leaving an etched surface that holds paint perfectly.

KEMICK, a chemical paint that holds to and protects metal surfaces even when red hot, has been used for years the world over on mild steel exhaust manifolds . . . can eliminate stainless steel exhaust lines. FLOSOL wets oily surfaces, is an exceptional soldering flux for steel, brass, copper, tin, terne plate and zinc.

ACP has been working steadily on the treatment of metals for the Aviation Industry—and all industries . . . the knowledge of ACP technicians and chemists is available to you.

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Other ACP Products that contribute to the war effort are: RODINE, the pickling inhibitor that saves steel and acid; CUPRODINE for producing tight, bright copper coatings on steel by simple immersion; LITHOFORM for coating galvanized iron to hold paint.

These are typical ACP Products. The experience of the ACP laboratories in metal treating and finishing processes is at your service.

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SHANGRI-LA TO TOKIO!

When the American Air Forces rained destruction on Tokio, Stromberg Injection Carburetors were used on all attacking planes. The mission was wholly successful.

Stromberg is proud of the part it played in this daring long range operation. Months of careful effort went into preparations. Fuel economy and consistency of metering were essential to the success of the mission and the safe return of the planes. This economy and predictable flight range were found in the Stromberg Injection Carburetor.

Because Stromberg Injection Carburetion is fully automatic, highly accurate in proportioning gasoline and air, and unaffected by flight attitude, it is standard equipment on the majority of American planes.

Stromberg

INJECTION CARBURETORS

BENDIX PRODUCTS DIVISION OF
BENDIX AVIATION CORPORATION
South Bend, Indiana

transporting finished forgings to the machine shops, and through the machine lines. At GM the big shell forgings are cold-nosed on a huge press. This is probably the first time that the cold-nosing procedure on large shells had a trial in production and it has worked out admirably.

The making of cartridge cases is an old art. In fact, the steps in the procedure remain unchanged even in mass production. But the equipment and the layout as it was developed at a GM plant, for example, was brand new and embody a major forward step in productivity and quality. Here will be found the familiar Bliss and Toledo presses with multiple indexing dies, automatic lathes, Lindberg furnaces, etc. For large cartridge cases, they have installed huge hydraulic presses built by Hydraulic Press Mfg. Co. Materials handling has been worked out along the lines of automotive practice, making the department extremely compact and most efficient in the use of time and labor.

Another innovation is the removal of scale by sandblasting, using the Pangborn equipment so widely employed throughout the industry for cleaning forgings and castings. No matter what item of ordnance materiel has been undertaken by an automotive producer, its processing and treatment have been worked out along the lines of automotive parts production, utilizing equipment which has given a good account of itself in our industry.

Military Vehicles

When it comes to the building of military vehicles and bogies, the industry can point with pride to the performance of one of the prominent axle manufacturers, whose engineers have worked with the Army for the past 20 years in preparation for the emergency. In consequence, axle design has been progressively improved and harmonized with the needs of military vehicles. Today, this manufacturer has swung most of its production facilities to the making of axles and bogies for military use, and is building these products with the same methods and substantially the same equipment as has been employed for civilian products of the same character. Perhaps the chief change lies in the fact that this manufacturer has found it necessary to bring in additional equipment so as to increase its capacity.

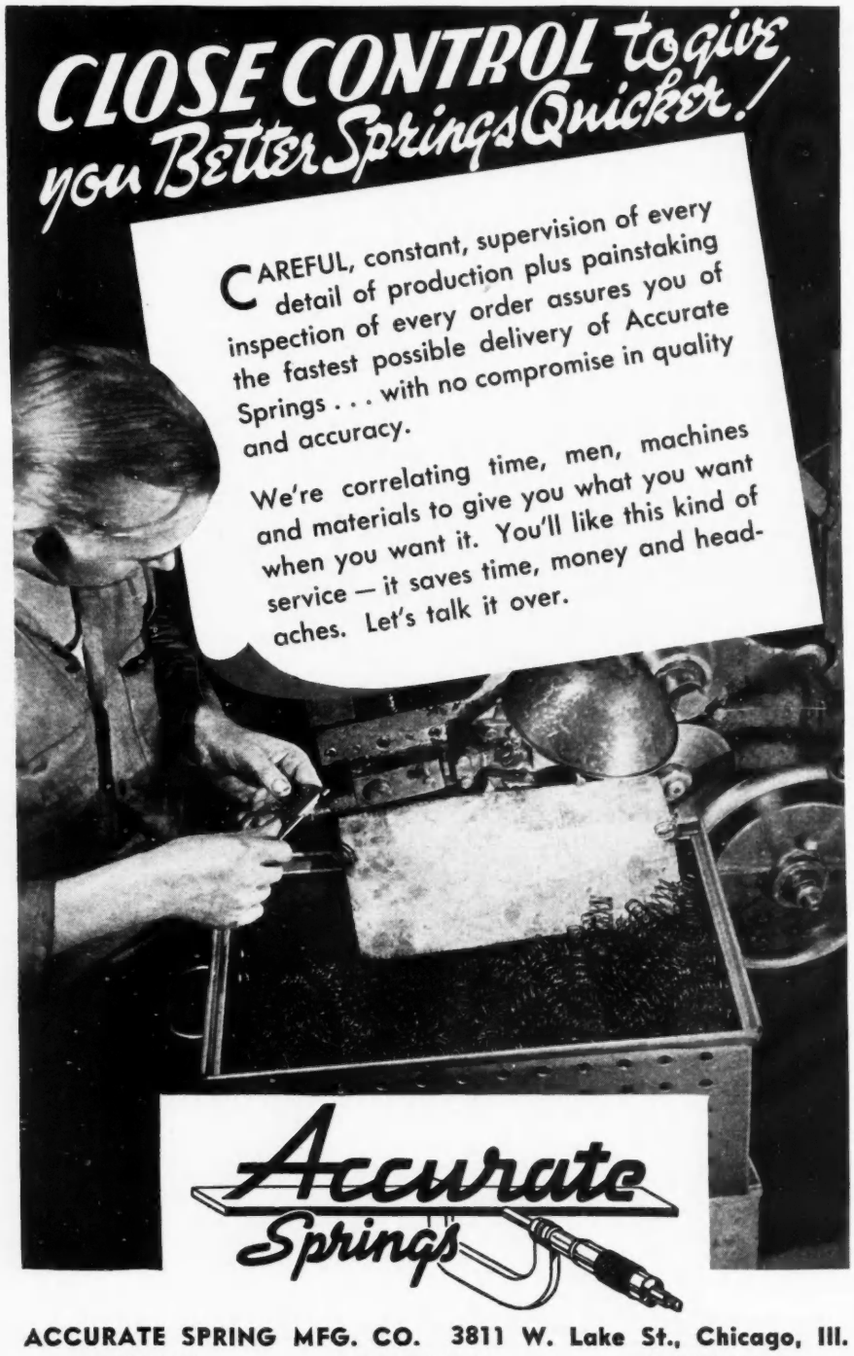
In much the same manner, a prominent axle and transmission manufacturer has turned all of its facilities to the needs of the war effort, making axles, light tank transmission, half-trac vehicle transmissions and transfer cases, universal joints, etc. In the main, this manufacturer is employing its original equipment for the manufacture of war products, supplemented with new tooling wherever required. However, in the case of the huge tank transmission it was necessary to acquire many new items of equipment such as the big radial drills, planers, and lathes.

Eaton and other suppliers in this field also have taken on orders for products quite similar to their regular line of parts, thus making it possible for them to shift onto war work without delay and without waiting for new machinery.

Air Lines Carry Vital Army Supplies

Utilizing existing facilities, and flying over established courses, 15 of the country's commercial airlines are now carrying an average of one million pounds of vital Army supplies each week. The new cargo lines, operated by airline personnel, comprise the Contract Air Cargo Division of the Army Air Forces.

Although a few planes specifically designed for cargo transport are now in service, most of the freight is being carried in conversions of the Douglas DC-3, the Lockheed Lodestar, and the Boeing 247. Both Douglas and Curtiss-Wright are building large cargo transports, many of which will be in service by the end of the year.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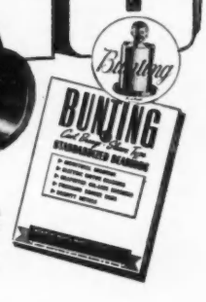


● Ask for catalog of Bunting Bronze Standardized Bearings and machined and finished Precision Bearing Bronze Bars available from local stocks.

The Specifications Problem

(*Continued from page* 17)

statement:

"In the interest of conservation of certain strategic materials, this specification was approved on the above date by the Director of Procurement, for the use of all departments and establishments of the Government, and shall become effective immediately as an Emergency Alternate Specification in the purchase of the commodity covered by it, where it may be considered a suitable alternate for materials covered by Federal Specifications."

This will serve to dispel the widely held notion that specifications will become less stringent permanently as a result of prevailing conditions. The moment the emergency is over, Federal pre-war specifications will regain their validity and prestige.

This, however, does not preclude taking full advantage of whatever metallurgists and engineers have learned as a result of their wartime experience. Regardless of future developments, competent critics are in agreement that many of the obstacles formerly in the way of a broader use of secondary metals can advantageously be brushed aside in the case of not a few products. Not in years to come, if ever, will tin again attain the importance in American economic life it had before the war. And specifications for bronzes and bearing metals may well undergo permanent revision as the result of what metallurgists and engineers are learning in this war.

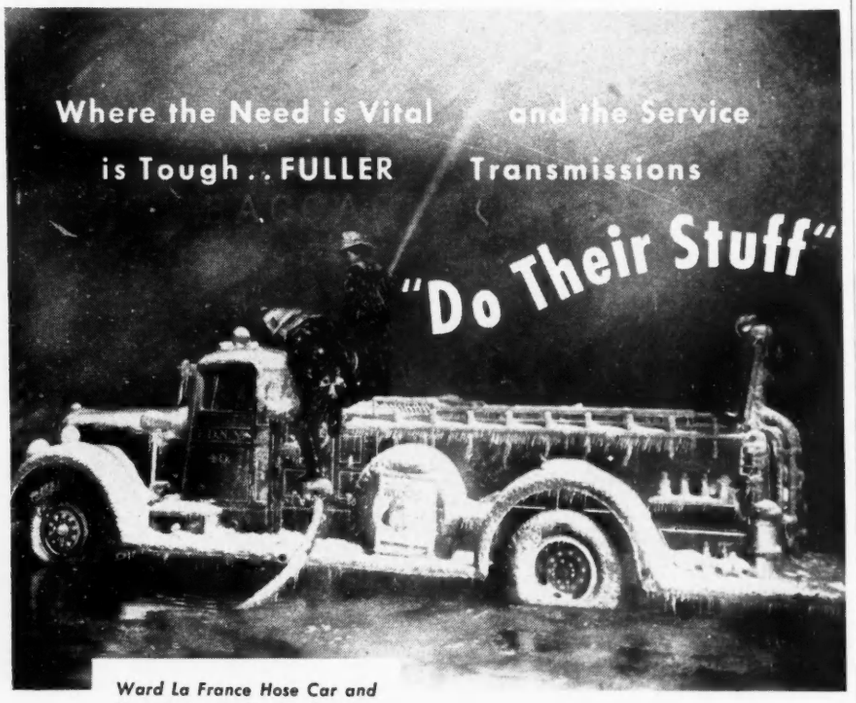
Since April, 1941, when this work got underway, approximately 275 Emergency Alternate Specifications which carry the prefix: "E" wherever referred to, have been issued. They are now being re-examined with a view to determining to what extent they could be made mandatory advantageously. A mandatory directive applies to all industries, but may not be binding on Army and Navy and other military agencies or only in non-combat uses.

Army engineers and those directing the work of the Navy Department's Bureau of Ordnance as well as the heads of the Army Air Corps and of the Navy's Bureau of Aeronautics are working in complete harmony with the War Production Board. This is nowhere more so the case than in the matter of specifications. The engineering officers of the services know from experience the demands made upon each piece of equipment and each category of munitions, and these requirements may in some cases differ slightly. Such minor variations, however, are relatively few and in no way affect the overall picture of the specifications setup. Under the regulations, War and Navy Departments have control over the specifications for materials in their respective departments, but no one recognizes more than the engineering officers of the services that concerted effort in the present emergency is indispensable and that these alternate specifications are an important tool in promoting the war effort.

Army to Test Synthetic Tires

The Army is going to test the performance and durability of auto tires made of synthetic rubber. Contracts have been awarded to tire and rubber companies for the manufacture of a large quantity of synthetic rubber tires, the War Department announced June 25. The experiment will be made in cooperation with the tire companies in order that comprehensive tests under realistic conditions may be accomplished quickly.

The tires will be made in four sizes—6.00-16, 6 ply; 7.50-20, 8 ply; 9.00-20, 10 ply; and 12.00-20, 14 ply. All will have treads for use in mud and snow. These tires will have the letter "S" branded or stamped into the sidewall to identify them as synthetic.



Ward La France Hose Car and Pumper in service in the New York City Fire Department. This apparatus is equipped with a FULLER Transmission.

Wherever trucks have a vital job to do — civilian or military, there you'll find FULLER Transmissions, helping to haul more loads at smaller cost.

And here at the FULLER plant, despite our tremendously enlarged and speeded up program, we never forget that quality as well as quantity, is a primary essential in every FULLER unit we ship today. For now, this extra FULLER reliability means not merely the difference between profit and loss, but oftentimes the difference between life and death to those who are fighting America's battles.

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